DNA 6013F

SHOTS ESS THROUGH MET AND SHOT ZUCCHINI

The Final TEAPOT Tests

23 March 1955-15 May 1955

United States Atmospheric Nuclear Weapons Tests
Nuclear Test Personnel Review

Prepared by the Defense Nuclear Agency as Executive Agency
for the Department of Defense

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER DNA 6013F	2. GOVT ACCESSION NO. AD-A114 082	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* SHOTS ESS THROUGH MET AND SHOT ZUCCHINI The Final TEAPOT Tests 23 March—15 May 1955		5. TYPE OF REPORT & PERIOD COVERED Technical Report 6. PERFORMING ORG. REPORT NUMBER JRB 2-816-03-423-00
7. AUTHOR(s) Jean Ponton, Carl Maag, Martha Wilkinson, Stephen Rohrer		8. CONTRACT OR GRANT NUMBER(s) DNA 001-79-C-0473
9. PERFORMING ORGANIZATION NAME AND ADDRESS JRB Associates 8400 Westpark Drive McLean, Virginia 22102		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Subtask U99QAXMK506-08
11. CONTROLLING OFFICE NAME AND ADDRESS Director Defense Nuclear Agency Washington, D.C. 20305		12. REPORT DATE 27 November 1981 13. NUMBER OF PAGES 260
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*		15. SECURITY CLASS. *(of this report)* UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

This work was sponsored by the Defense Nuclear Agency under RDT&E RMSS Code B350079464 U99QAXMK50608 H2590D. For sale by the National Technical Information Service, Springfield, VA 22161.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

TEAPOT	HA	AFSWP
ESS	POST	AFSWC
HADR	MET	
APPLE 1	ZUCCHINI	
WASP PRIME	Exercise Desert Rock VI	

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report describes the activities of DOD personnel, both military and civilian, in Shots ESS, HADR, APPLE 1, WASP PRIME, HA, POST, MET, and ZUCCHINI, the latter eight events of the TEAPOT atmospheric nuclear weapons test series. Shot APPLE 2, the next to the last TEAPOT test event, is described in a separate volume. These tests were conducted from March 23 to May 15, 1955 and involved participants from Exercise Desert Rock VI, AFSWP, AFSWC, AEC nuclear weapons development laboratories, and the Civil Effects Test Group. This volume also describes the radiological safety activities undertaken at each shot.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

18. SUPPLEMENTARY NOTES (Cont.)
The Defense Nuclear Agency Action Officer, Lt. Col. H. L. Reese, USAF, under whom this work was done, wishes to acknowledge the research and editing contribution of numerous reviewers in the military services and other organizations in addition to those writers listed in block 7.

PREFACE

Between 1945 and 1962, the United States Government, through the Manhattan Engineer District and its successor agency, the Atomic Energy Commission (AEC), conducted 235 atmospheric nuclear weapons tests at sites in the southwestern U.S. and in the Pacific and Atlantic Oceans. In all, an estimated 220,000 Department of Defense (DOD) participants, both military and civilian, were present at the tests. Approximately 90,000 of these participants were present at the nuclear weapons tests conducted at the Nevada Test Site (NTS), northwest of Las Vegas, Nevada.

In 1977, 15 years after the last above-ground weapons test, the Center for Disease Control* noted a possible leukemia cluster among a small group of soldiers present at Shot SMOKY, the 15th weapons-related test of Operation PLUMBBOB, the series of atmospheric nuclear weapons tests conducted in 1957. Since that initial report by the Center for Disease Control, the Veterans Administration has received a number of claims for medical benefits from former military personnel who believe their health may have been affected by their participation in the atmospheric nuclear weapons tests.

In late 1977, DOD began a study that provided data to both the Center for Disease Control and the Veterans Administration on possible exposures to ionizing radiation among its military and civilian personnel who participated in the atmospheric nuclear weapons tests 15 to 30 years earlier. The Department of Defense organized an effort to:

- Identify DOD personnel who had taken part in the atmospheric nuclear weapons tests

*The Center for Disease Control, part of the U.S. Department of Health and Human Services (formerly the U.S. Department of Health, Education, and Welfare).

- Determine the extent of the participants' exposure to ionizing radiation
- Provide public disclosure of information concerning participation by DOD personnel in the atmospheric nuclear weapons tests.

This report on seven nuclear tests of Operation TEAPOT is based on the historical record of military and technical documents associated with each of the nuclear weapons tests. These reports provide a public record of the activities and possible radiation exposure of DOD personnel, for ongoing public health research and policy analysis.

Many of the documents pertaining specifically to DOD involvement during these seven shots of Operation TEAPOT were found in the Defense Nuclear Agency Technical Library, the National Federal Archives Record Center, the Department of Energy Nevada Operations Office, the Los Alamos National Laboratory* Technical Library, and the Modern Military Branch of the National Archives.

Commonly, the surviving historical documentation of activities conducted at Shots ESS, APPLE 1, WASP PRIME, HA, POST, MET, and ZUCCHINI addresses test specifications and technical information, rather than the personnel data critical to the study undertaken by the Defense Nuclear Agency. Moreover, instances have arisen in which available historical documentation has revealed inconsistencies in vital factual data, such as the number of DOD participants in a certain project at a given shot or their locations and assignments at a given time. These inconsistencies in data usually occur between two or more documents, but occasionally appear within the same document. Efforts have been made to resolve these data inconsistencies wherever possible, or to otherwise bring them to the attention of the reader.

*Formerly the Los Alamos Scientific Laboratory (LASL,

An important example of such discrepancies is the documentation dealing with air operations at Operation TEAPOT. Several postshot and post-series documents were analyzed to determine the nature and extent of these air activities, including Parsons' Operational Summary (WT-1158) and Fackler's Technical Air Operations (WT-1206). The Operational Summary provides an overview of all activities conducted during the testing, primarily those of AFSWP. Technical Air Operations, however, is a more specific document, chronicling in detail the air operations of DOD personnel. Discrepancies as to numbers of aircraft actually participating in any single event exist between these two documents and other TEAPOT documents. When possible, these discrepancies were resolved through additional research. In those cases for which further research failed to resolve the problem, the Technical Air Operations report, WT-1206, was used because it deals specifically with air operations at TEAPOT and therefore is considered the more reliable document for determining the extent and nature of air operations.

For several of the Desert Rock VI and Joint Test Organization (JTO) projects discussed in the TEAPOT volumes, the only historical documents available are the Sixth Army's Desert Rock VI Operations Orders and the Test Director's schedule of events from "Operation Order 1-55." These sources detail the plans developed by DOD and AEC personnel prior to the TEAPOT Series; they do not describe the projects as conducted at the NTS. After-action documents, such as the "Final Report of Operations for Exercise Desert Rock VI" and the Weapons Tests Reports for AFSWP, summarize the projects performed during the TEAPOT Series, but do not always supply shot-specific information. Therefore, it is not known if all of the projects addressed in the planning documents and discussed in this volume were conducted exactly as planned.

ORGANIZATION AND CONTENT OF TEAPOT SERIES REPORTS

This volume details participation by DOD personnel in seven of the last eight events of the Operation TEAPOT nuclear weapons testing series. Four other publications address DOD activities during the TEAPOT Series:

- Series Volume: Operation TEAPOT, Atmospheric Nuclear Weapons Tests, 1955
- Multi-shot Volume: Shots WASP to HORNET, the First Five TEAPOT Tests
- Shot Volume: Shot BEE
- Shot Volume: Shot APPLE 2.

The volumes addressing the test events of Operation TEAPOT have been designed for use with one another. The Series volume contains information that applies to those dimensions of Operation TEAPOT that transcend specific events, such as historical background, organizational relationships, and radiological safety procedures. In addition, the TEAPOT Series volume contains a bibliography of works consulted in the preparation of all five Operation TEAPOT reports. The two single-shot volumes describe DOD participation in Shots BEE and APPLE 2. These two events have been bound separately because they included significant Exercise Desert Rock maneuvers involving large numbers of DOD personnel. Each multi-shot volume combines shot-specific descriptions for several nuclear events. The shot and multi-shot volumes contain reference lists only of the sources referenced in each text. Descriptions of activities concerning any particular shot in the TEAPOT Series, whether the shot is addressed in a single-shot volume or in a multi-shot volume, should be supplemented by the general, organizational, and radiological safety information contained in the TEAPOT Series volume.

The information in these reports is supplemented by the Reference Manual: Background Materials for the CONUS Volumes, which contains summary information on radiation physics,

radiation health concepts, exposure criteria, and measurement techniques, as well as a list of acronyms and a glossary of terms used in the Nuclear Test Personnel Review reports addressing test events in the continental U.S.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Continued)

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

The following abbreviations and acronyms are used in this volume:

AEC	Atomic Energy Commission
AFB	Air Force Base
AFSWC	Air Force Special Weapons Center
AFSWP	Armed Forces Special Weapons Project
BJY	Buster-Jangle "Y"
CETG	Civil Effects Test Group
CONUS	Continental United States
DOD	Department of Defense
DWET	Directorate Weapons Effects Tests
EG and G	Edgerton, Germeshausen, and Grier
FCDA	Federal Civil Defense Administration
IBDA	Indirect Bomb Damage Assessment
GZ	Ground Zero
JTO	Joint Test Organization
LASL	Los Alamos Scientific Laboratory
NTS	Nevada Test Site
OCAFF	Office, Chief of Army Field Forces
REECo	Reynolds Electrical and Engineering Company
R/h	Roentgens per hour
UCRL	University of California Radiation Laboratory
USAF	United States Air Force
UTM	Universal Transverse Mercator

CHAPTER 1

INTRODUCTION

Shots ESS, APPLE 1, WASP PRIME, HA, POST, MET, and ZUCCHINI were tests of nuclear devices conducted between 23 March and 15 May 1955 at the Nevada Test Site (NTS), the U.S. Atomic Energy Commission (AEC) continental nuclear test site located northwest of Las Vegas. These were seven of the last eight nuclear test events of Operation TEAPOT,* a series of 14 nuclear weapons tests and one non-nuclear test performed between 18 February and 15 May 1955. Shot HADR was a non-nuclear dry run for the HA (High Altitude) detonation. HADR is discussed with Shot HA in chapter 5.

The devices detonated at Shots APPLE 1, WASP PRIME, POST, and ZUCCHINI, were tests sponsored by the Los Alamos Scientific Laboratory (LASL) or the University of California Radiation Laboratory (UCRL), the two AEC nuclear weapons development laboratories. The remaining three nuclear devices, detonated at Shots ESS, HA, and MET, were weapons previously developed and tested by the weapons laboratories and drawn from the nuclear arsenal. These events were sponsored by the Department of Defense (DOD). ESS and HA were used to test specific military applications and MET, as the acronym implies, was a "military effects test." The primary objective of the seven nuclear tests was to evaluate the nuclear yield and the blast, thermal, and radiation phenomena produced by the devices. To fulfill this objective, LASL and UCRL test groups conducted scientific experiments to measure the physical characteristics of the detonations. The Armed Forces Special Weapons Project

---

*Shot APPLE 2 was conducted within this same time span, on 5 May, 1955, between Shot MET and Shot ZUCCHINI. However, because of the large number of DOD participants, more than 2,000 individuals, Shot APPLE 2 is discussed in a separate shot volume.

(AFSWP) Field Command Military Effects Group conducted projects to evaluate the utility of the four developmental devices for military applications, and to investigate additional requirements for future nuclear weapons development at all seven test events.

A number of other activities related to the conditions and phenomena produced by a nuclear detonation were also conducted at the tests. DOD conducted operational training projects to test service tactics and equipment and to train personnel in the effects of a nuclear detonation. The Federal Civil Defense Administration (FCDA) Civil Effects Test Group (CETG) conducted projects to assess the effects of nuclear detonations on civilian populations, products, and food supplies, and to evaluate Civil Defense emergency preparedness plans. The armed services also fielded projects to evaluate military equipment and tactics as part of Exercise Desert Rock VI, the Army technical testing and training program at Operation TEAPOT.

Table 1-1 summarizes the last nine tests of the TEAPOT Series, including the non-nuclear Shot HADR, and Shot APPLE 2, which is discussed in a separate volume. The table provides information such as dates of shots, the UTM coordinates* of the points of detonation, the heights of burst+ and the explosive yields. Figure 1-1 displays a map of the NTS in 1955, with the positions of each of the TEAPOT tests.

---

*Universal Transverse Mercator (UTM) coordinates are used in this report. The first three digits refer to a point on an east-west axis, and the second three refer to a point on a north-south axis. The point so designated is the southwest corner of an area 100 meters square.

+Altitudes are measured from mean sea level while heights are measured from the ground. All vertical distances are given in feet. Yucca Flat, the area of the NTS where six of the nuclear events were tested, is about 4,000 feet above sea level. Frenchman Flat, the location of the MET detonation, is about 3,000 feet above sea level.

Table 1-1: SUMMARY OF THE FINAL OPERATION TEAPOT EVENTS

Shot	ESS	HADR	APPLE1	WASP PRIME	HA	POST	MET	APPLE2*	ZUCCHINI
Sponsor	DOD	DOD	LASL	LASL	DOD	UCRL	LASL/ DOD	LASL	LASL
Planned Date	15 March	1 March	18 March	20 March	4 March	1 March	1 March	26 April	1 April
Actual Date	23 March	25 March	29 March	29 March	6 April	9 April	15 April	5 May	15 May
Local Time	1230	0900	0455	1000	1000	0430	1115	0510	0500
NTS Location	Area 10	Area 1	Area 4	Area 7	Area 1	Area 9	French-man Flat	Area 1	Area 7
UTM Coordinates	849138	—	797056	869047	—	860086	956728	798009	867056
Type of Detonation	Shaft	Airdrop	Tower	Airdrop	Airdrop	Tower	Tower	Tower	Tower
Height of Burst (Feet)	−67	38,000†	500	737	36,620†	300	400	500	500
Actual Yield (kt.)	1	non-nuclear	14	3	3	2	22	29	28

*Addressed in a separate report.
† Mean sea level

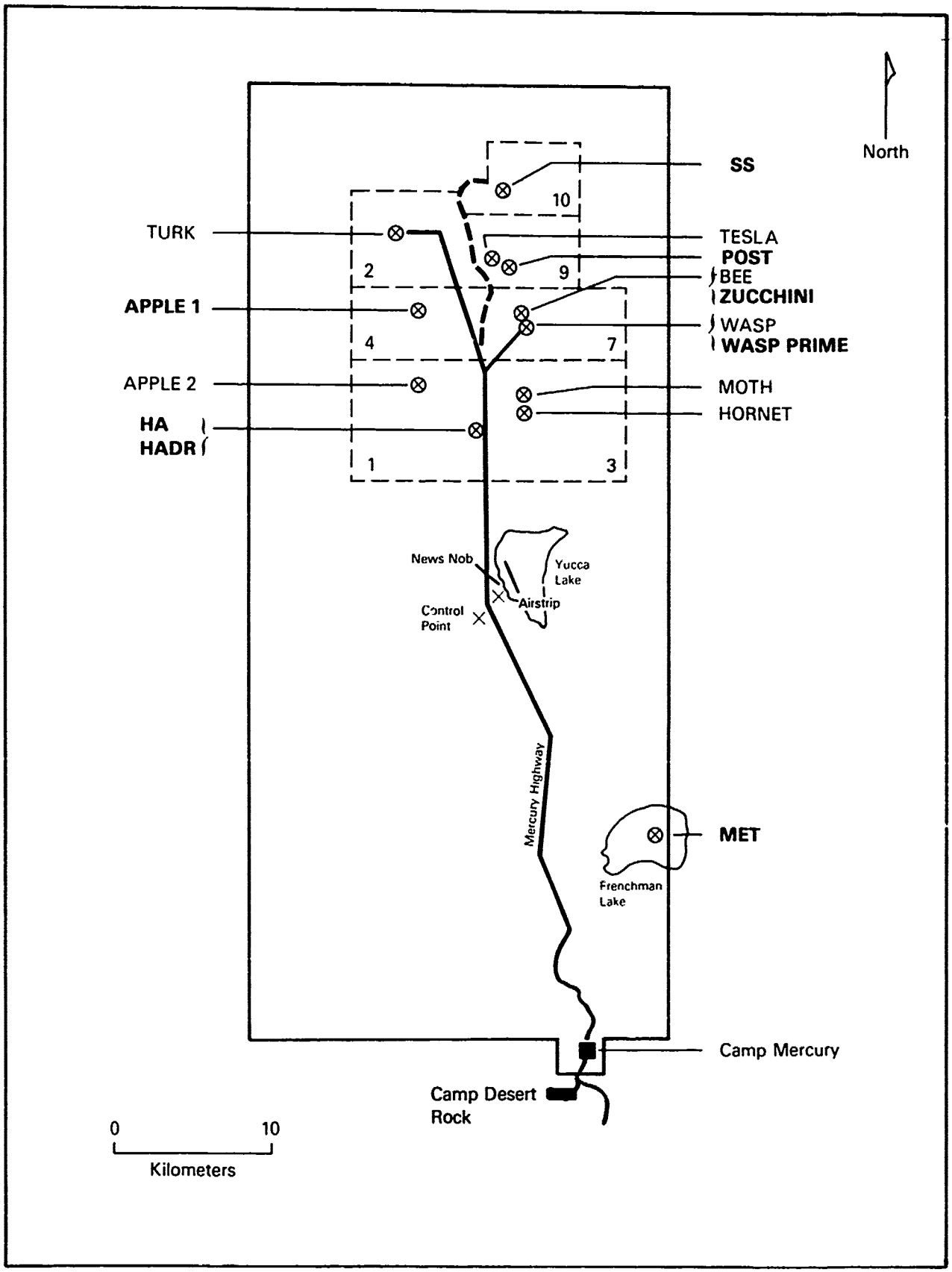


Figure 1-1: LOCATION OF SHOTS ESS, HADR, APPLE 1, WASP PRIME, HA, POST, MET, AND ZUCCHINI IN THE NEVADA TEST SITE

1.1 DEPARTMENT OF DEFENSE INVOLVEMENT IN JOINT TEST ORGANIZATION ACTIVITIES AT THE FINAL TEAPOT EVENTS

The Joint Test Organization (JTO) was established for planning, coordinating, and conducting all nuclear weapons tests during Operation TEAPOT. All activities were under the control of an AEC-appointed Test Manager assisted by the Test Director. The JTO was composed of personnel from AEC, DOD, and FCDA. These personnel were assigned to four JTO test groups: the AFSWP Military Effects Group, the LASL Test Group, the UCRL Test Group, and the FCDA Civil Effects Test Group. In addition to the projects of the test groups, the DOD conducted operational training projects and support activities. Two areas of support for JTO in which DOD personnel were active were the 1st Radiological Safety Support Unit of Ft. McClellan, Alabama, with 112 soldiers providing onsite radiological safety monitoring, and AFSWC air and ground personnel, providing air traffic control and air support.

Overall, the most extensive DOD participation in the JTO test groups was in the Military Effects Group, designed to study yield and weapons effects characteristics in order to understand the militarily useful effects of nuclear weapons for offensive and defensive deployment. Personnel from DOD agencies and the four armed services also assisted in the experiments conducted by LASL, UCRL, and CETG, but participation was limited and difficult to determine. The major portion of DOD participation in these experiments was performed by the AFSWC 4926th Test Squadron (Sampling) in LASL and UCRL radiochemistry cloud sampling projects.

The DOD operational training projects, designed to test service tactics and equipment and to train military personnel in nuclear detonation effects, were conducted at each of the seven shots. Most of the projects were conducted by the Air Force, although the Navy and the Marine Corps also conducted operational training projects.

The Air Force Special Weapons Center (AFSWC), at Kirtland Air Force Base (AFB), New Mexico, exercised operational control of all military aircraft flying in the area of the NTS during TEAPOT and provided air support to the JTO Test Manager and to test group projects. AFSWC was composed of units of the 4925th Test Group (Atomic), including the 4926th Test Squadron (Sampling) and the 4935th Air Base Squadron. These units operated out of Indian Springs AFB, 38 kilometers southeast of the NTS, and were supported by the 4900th Air Base Group* stationed at Kirtland AFB. In all, about 600 AFSWC air and ground personnel provided air support to JTO projects, conducting cloud-sampling and cloud-tracking missions; performing the air-drops for WASP PRIME, HA, and the non-nuclear High Altitude Dress Rehearsal (HADR) test events; and providing courier, survey, and transportation services.

Radiation protection procedures established by the JTO are detailed in the TEAPOT Series volume. These safety procedures were designed to minimize exposure to ionizing radiation by limiting any exposures to no more than 3.9 roentgens of whole-body gamma for any 13-week period and 15 roentgens annually. To implement these criteria, the 1st Radiological Safety Support Unit controlled access to radiation areas within the NTS after each detonation. JTO project personnel recovering test instruments from highly radioactive areas were accompanied by radiological safety monitors. These monitors continuously surveyed the radiation intensity in the recovery area and alerted the project leaders if intensities were too high or the length of time in the area was too long. To monitor cumulative exposures, project personnel were issued film badges to wear at all times when in the shot areas. These film badges were collected,

*Prior to 5 May 1955, the 4900th Air Base Group was called the 4901st Air Base Wing. Because the group ended the Series as the 4900th, it will be called the 4900th Air Base Group throughout the volume.

developed, and evaluated at certain intervals. Any individual whose accumulated dose approached or exceeded the established limits was barred from further access to the forward test area. The 1st Radiological Safetv Support Unit also implemented personnel decontamination procedures and developed emergencv evacuation plans for all test events, although none were necessary (12; 19).*

The radiation protection procedures for AFSWC included the same exposure limits for aircrews and ground crew personnel as those established for JTO personnel, with the special exception of the aircrews of Project 2.8b. These AFSWC personnel were authorized by the AEC Test Manager to receive a cumulative maximum of 15 roentgens of gamma radiation throughout the TEAPOT Series (13). Complete decontamination, including removal of protective clothing and showers, was required of all aircrew members after each project mission, regardless of the exposure received on the flight. Aircraft were decontaminated by washing or were isolated until radiation intensities had decaved to acceptable levels (35; 38).

1.2 EXERCISE DESERT ROCK VI ACTIVITIES AT THE FINAL SEVEN TEAPOT EVENTS

Most of the DOD personnel involved in Shots ESS, APPLE 1, WASP PRIME, POST, and MET were participants in the projects fielded by Exercise Desert Rock VI, the Armv testing and training program conducted during Operation TEAPOT. No Desert Rock exercises were conducted at Shots HA and ZUCCHINI. The projects included troop orientation and indoctrination projects, troop tests, and technical service projects.

*All sources cited in the text are listed alphabeticallv and numbered in the Reference List, appended to this volume. The number given in the citation in the text is the number of the source document in the Reference List.

In addition to the Desert Rock exercise troops, Camp Desert Rock troops from various Army units provided communication, transportation, traffic control, and radiological safetv monitoring for Desert Rock projects at the five shots. The soldiers from the 50th Chemical Service Platoon provided radiological safetv monitoring for Desert Rock personnel in the shot areas following each detonation (54).

Radiation protection procedures for Exercise Desert Rock VI, like those for the JTO, are detailed in the accompanving TEAPOT Series volume. Procedures were designed to minimize potential exposure to ionizing radiation while allowing participants to accomplish their project objectives. Camp Desert Rock personnel and exercise participants were limited to no more than six roentgens of whole-bodv gamma radiation during any six-month period. The radiation protection procedures of Exercise Desert Rock VI included provisions for:

- Maintaining minimum safe distances from nuclear detonations
- Enforcing protective procedures for personnel observing the detonations
- Controlling access to radiation areas
- Monitoring individuals working in radiation areas
- Film badging and monitoring the cumulative exposure of Desert Rock personnel
- Decontaminating all equipment and personnel leaving the shot area after each detonation.

1.3 ORGANIZATION OF THE SHOTS ESS TO MET AND SHOT ZUCCHINI VOLUME

This chapter has addressed the phvsical setting and general characteristics of the final seven TEAPOT test events, with the exception of APPLE 2, and brieflv introduced the Desert Rock maneuvers and those JTO activities in which DOD personnel participated.

The remaining seven chapters address each of the TEAPOT tests in turn. Each chapter describes the specific setting and characteristics of one detonation, details DOD personnel activities in the military effects, scientific, training, and support activities performed by Exercise Desert Rock VI, JTO, and AFSWC, and discusses the radiation protection procedures implemented to minimize the potential for unauthorized exposures to ionizing radiation. Details of the overall radiation protection program at Operation TEAPOT are provided in the Series volume.

ESS

SHOT SYNOPSIS

AEC TEST SERIES:	TEAPOT
DOD EXERCISES:	Desert Rock VI
DATE/TIME:	23 March 1955, 1230 Hours
YIELD:	1 kiloton
HEIGHT OF BURST:	-67 feet (subsurface)

Purpose of Test: To test a nuclear weapon for possible inclusion in the nuclear arsenal as an atomic demolition munition (ADM).

Objectives: (1) To emplace and test the atomic demolition munition.
(2) To allow DOD personnel to observe a test of an atomic demolition munition.

Weather: At shot-time, the surface temperature was at 18° C.; pressure at 883 millibars; winds from the northwest at 10 knots at the surface gradually increasing to about 25 knots north-northwest at 10,000 feet.

Radiation Data: During the initial survey, taken from 1310 to 1450 hours on shot-day, onsite fallout greater than 0.01 R/h occurred mainly east-southeast of ground zero, but extended up to 2,500 meters southwest of ground zero.

Participants: Atomic Energy Commission, Exercise Desert Rock participants, Armed Forces Special Weapons Project, Air Force Special Weapons Center and other Air Force personnel, Federal Civil Defense Administration, contractors, DOD laboratories.

CHAPTER 2

SHOT ESS

Shot ESS, the seventh nuclear test of Operation TEAPOT, was the only nuclear device of the Series to be detonated underground. Originally planned for 15 March 1955, the detonation was postponed until 0900 hours on 23 March because of technical and weather delays. Changing wind directions caused a final delay of three and one half hours, until 1230 hours. The ESS event, sponsored by the Department of Defense (DOD), was an operational test of an atomic demolition munition (ADM) and was detonated 67 feet underground in Area 10 of Yucca Flat, at UTM coordinates 849138. The yield of the device was one kiloton (30). The cloud top reached a maximum height of 12,000 feet. The nuclear cloud and subsequent fallout drifted in an easterly direction. Fallout was detected as far as 225 kilometers* from ground zero (35; 41; 69).

Because the ADM was buried underground, the detonation blew tons of earth upward, creating a crater 88 meters in diameter and 96 feet deep. Ten minutes after the blast, monitoring of the ESS crater indicated a radiation intensity of 8,000 R/h. Radiation levels in the fallout pattern included some residual radiation from Shot BEE, detonated one day earlier, on 22 March in Area 7. No aircraft except survey helicopters were allowed within a 3.2-kilometer radius of the crater for three days after the detonation (35; 69).

At shot-time, more than 300 military personnel from the Army, Navy, Marine Corps, and Air Force were positioned in the

*Throughout this report, surface distances are given in metric units. The metric conversion factors include: 1 meter = 3.28 feet; 1 meter = 1.09 yards; and 1 kilometer = 0.62 miles.

open 8,230 meters southwest of ground zero to observe. An estimated 168 Navy personnel were also present to perform a Passive Defense Training project. In addition, Army personnel from a task unit of the 271st Engineer Combat Battalion had prepared the shaft for the test, and an eight-man team from Company B, 10th Ordnance Battalion (Special Weapons Support) Weapons Assembly Team had helped with delivering and assembling the device. Additional Army personnel from Battery C (-),* 532nd Field Artillery (Observation) Battalion occupied ten instrumented bunker stations between 11 and 20 kilometers south of ground zero to determine the location and yield of the detonation. Other DOD personnel in the shot area included those performing radiological safety functions, Military Effects Group projects, and one operational training project. The Air Force used ESS to simulate a nuclear bomb drop from a low altitude. To perform this simulation, a jet fighter flew due north over the BUSTER-JANGLE "Y" (BJY) and toward ground zero at a very low altitude, probably less than 5,000 feet, seconds before the detonation. The aircraft climbed straight up before the device was fired in an escape maneuver. Figure 2-1 indicates the location of DOD personnel in the shot area at the time of the detonation.

DOD participants at Shot ESS took part in Exercise Desert Rock activities, scientific and military effects experiments, and support missions, as described in this chapter. An account of the radiological situation created by Shot ESS, along with the procedures used to minimize the exposure of DOD participants to ionizing radiation, is summarized at the end of the chapter.

2.1 EXERCISE DESERT ROCK VI OPERATIONS AT SHOT ESS

Almost 800 Desert Rock exercise and support troops took part in three troop orientation and indoctrination projects, two troop

*Some subordinate units were not present.

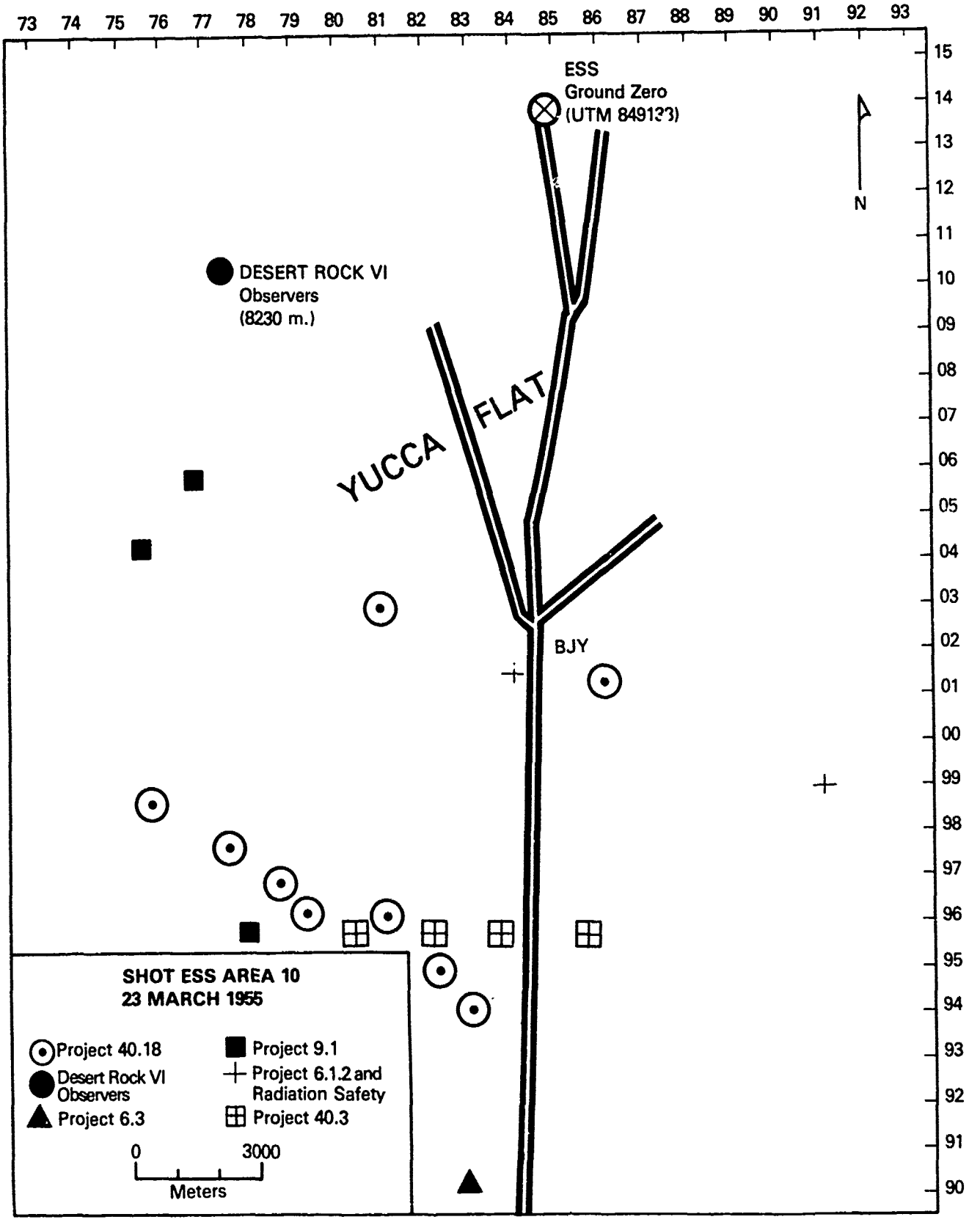


Figure 2-1: FORWARD POSITIONS OF DOD PERSONNEL AT SHOT-TIME FOR ESS

tests, and two technical service projects. Camp Desert Rock personnel were also present to observe the shot, but they were not part of a numbered project. Table 2-1 lists Desert Rock VI activities at ESS, including the numbers and titles of the programs and projects, the project sponsors, the estimated numbers of DOD participants, and the service units involved in the projects.

Table 2-1: EXERCISE DESERT ROCK VI PROJECTS, SHOT ESS

Program Type	Project	Title	Estimated Personnel	Participants
Troop Orientation and Indoctrination	41.3	Army Observers	168	Army
	40.11	Marine Observers	9	Marine Corps
	41.8	Air Force Observers	3	Air Force
	—	Camp Desert Rock Observers	176	Camp Desert Rock Support Troops
Troop Test	40.16	Army Demolition Munitions	210	271st Engineer Combat Battalion; Co. B, 10th Ordnance Battalion (SWS)
	40.18	Location of Atomic Bursts	53	Battery C (-), 532nd Field Artillery (Observation) Battalion
Technical Service	40.9	Navy Passive Defense Training	168	Navy Bureau of Ships; Naval Radiological Defense Laboratory
	40.21	Ordnance Vehicular Equipment Test	*	Ballistic Research Laboratories; 573rd Ordnance Company; Detroit Arsenal; Chemical Warfare Laboratory

* Unknown

2.1.1 Troop Orientation and Indoctrination Projects

Three troop orientation and indoctrination project groups and a group of Camp Desert Rock support troops watched the ESS detonation in open terrain 8,230 meters southwest of the ESS surface zero, at UTM coordinates 773104. In addition, participants in the Navy Passive Defense Training project observed the shot from this location (54; 56; 58; 88). Figure 2-2 shows the observers watching the ESS detonation. All observers took part

Figure 2-2: DESERT ROCK OBSERVERS WATCH ESS DETONATION
8,230 METERS FROM GROUND ZERO

in the same orientation and training activities prior to the event.

The observers proceeded through the Camp Mercury security gate on shot-day and traveled north on Mercury Highway, reaching the observation site at about 0800 hours, one hour before the scheduled shot-time. At some point before 0900 hours, it was announced that the shot was delayed. The troops remained at the observer location. Following preshot checks and orientation, they waited through the countdown to the detonation at 1230 hours. Twenty minutes after the shot, the observers boarded buses for the return trip to Camp Desert Rock (43; 54; 56; 58; 88).

2.1.2 Troop Tests

Two troop tests were conducted to provide data on military tactics and doctrine, and to train command and staff personnel in planning and conducting combat operations under the anticipated conditions of a nuclear battlefield.

Project 40.16, Army Test of Atomic Demolition Munitions, was the task of placing and testing the atomic demolition munition detonated at the ESS event. The project was conducted by a task unit of ten officers and 200 enlisted men from the 271st Engineer Combat Battalion. The task unit included eight men from Company B, 10th Ordnance Battalion (SWS),* who comprised the Forward Assembly Team. Between 1 and 20 November 1954, the unit trained at the Army's Engineer School, Fort Belvoir, Virginia.

On 6 January 1955, the engineer task unit from the 271st Engineer Combat Battalion arrived at Camp Desert Rock, and was joined on 24 January by the Forward Assembly Team, the arming and

*Special Weapons Section

firing segment of the project team. On February 1, combined troop training with an eight-man Forward Assembly Team began at Camp Desert Rock. When training was completed, the engineer task unit moved to the designated shot area of the NTS and began excavating a shaft 70 feet deep and 10.5 feet in diameter. This task took several weeks to complete. At 0100 hours on 23 March, the assembly party, consisting of nine military personnel from the engineer task unit and the team of special weapons personnel, proceeded to Area 10 to place the ESS device. This task was expected to take approximately two hours. At 0330 hours, the arming party left the Control Point and traveled to Area 10 to arm the weapon. In addition to the arming party, 36 men of the task unit were present in the shot area to finish backfilling the shaft. By 0600 hours, or dawn on shot-day, the arming party and the task unit personnel probably completed their work and proceeded to the Desert Rock observation area, to await the detonation. They returned to Camp Desert Rock with the observers shortly after the detonation (4; 54; 58; 60; 88).

Project 40.18, Location of Atomic Bursts, performed by Battery C (-) 532nd Field Artillery (Observation) Battalion, examined the suitability of conventional military equipment, procedures, and techniques developed by The Artillery School for locating nuclear bursts.

The project required 53 personnel to establish and occupy ten observation stations during the detonation. Their mission was to establish a three-dimensional location of the detonation by monitoring AN/TVS-1 cameras, MK-11 Bhangmeters, AN/MPQ-21X radar sets and microphones. The ten stations were at the following locations (54; 58; 88):

STATION	UTM COORDINATES
Flash Control Point	794964
Station #1	834945
Station #2	824953
Station #3	810961
Station #4	789969
Station #5	775976
Station #6	758985
Sound Control Point 1	862014
Sound Control Point 2	810030
Radar	800912

These stations were positioned to approximate the standard deployment of an observation battery under tactical conditions. They were located several kilometers apart, along a northwest to southeast line 11 to 20 kilometers south of ground zero.

The ten stations were to be occupied from about 1630 hours on the day before the event until just after the detonation. During the event, project personnel attempted to identify the position of the detonation on a three-dimensional grid and to assess the yield of the device. Following the test, project personnel returned to Camp Desert Rock (54; 58; 88).

2.1.3 Technical Service Projects

Two technical service projects were conducted to train personnel in the effects of nuclear detonations on vehicles and to determine how to establish safe working conditions in and near radiation areas.

Project 40.9, Navy Passive Defense Training, was conducted by the Bureau of Ships, with technical direction provided by the Naval Radiological Defense Laboratory. The project at ESS was used to train 168 Navy civilian shipyard and laboratory personnel in establishing safe working conditions close to a nuclear detonation. These men were stationed at Camp Desert Rock from 16 to 30 March to participate in this exercise. Table 2-2 indicates the agencies participating in Project 40.9 (31; 110).

Table 2-2: UNITS AND AGENCIES IN DESERT ROCK PROJECT 40.9

Boston Naval Shipyard
Bureau of Medicine and Surgery
Bureau of Ships
Bureau of Supplies and Accounts
Bureau of Yards and Docks
Charleston Naval Shipyard
Chief of Naval Operations
David Taylor Model Basin
Long Beach Naval Shipyard
Mare Island Naval Shipyard
Naval Electronics Laboratory
Naval Engineer Experimentation Station
Naval Gun Factory
Naval Radiological Defense Laboratory
Naval Repair Facility
Navy Mine Countermeasures Station
New York Naval Shipyard and Materiel Laboratory
Norfolk Naval Shipyard
Pearl Harbor Naval Shipyard
Philadelphia Naval Shipyard
Portsmouth Naval Shipyard
Puget Sound Naval Shipyard
San Francisco Naval Shipyard
Underwater Sound Naval Laboratory
9th Naval District, Chicago

Upon arrival at Camp Desert Rock, project participants were assigned to six emergency recovery units. In addition to trainees, each unit, organized according to the Navy Passive Defense Manual, included a commander, a personnel officer, an electronics officer, a dosimetry officer, a transportation officer, and an operations officer for each day's field activities. These positions were filled by personnel from within the training unit. In addition, each unit was assigned two instructors from the Naval Radiological Defense Laboratory.

Each unit was assigned one truck and four jeeps, one of which was equipped with a radio. Personnel were issued trousers, jackets, field shoes, parkas, and gloves. Protective clothing, such as booties, high-density goggles, coveralls, caps, and respirators, was distributed as required. Each unit was issued radiac equipment for monitoring radiation levels encountered in the field, portable communications equipment, dosimeters, and film badges.

The emergency recovery units spent 18 March in orientation briefings and processing, and attended a series of courses on radiation and dosimetry techniques and procedures on 19 March. On 20 March, the units participated in field training exercises designed to familiarize personnel with the area in which their activities would be conducted. The units spent 21 March at briefings. The schedule for 22 March, the day before shot-day, was arranged to permit personnel to watch the BEE detonation planned for that morning. All units, at full strength, observed Shot BEE and then returned to Camp Desert Rock. The training program continued with a project meeting, consisting of a preview of shot-day activities and a discussion of plans for the day following shot-day. On 23 March, shot-day, all units left in a vehicle convoy at 0530 hours for the observation area to observe the ESS detonation (31; 110).

At 1250 hours, 20 minutes after the detonation, the project commander issued orders, on the approval of the Test Manager, for the Navy Passive Defense Teams to move into the field to conduct monitoring operations. The teams proceeded to six stations at the following locations (54; 58; 88; 105):

STATION	UTM COORDINATES
Station #1	832159
Station #2	855099
Station #3	826152
Station #4	855097
Station #5	834141
Station #6	851089

The purpose of this monitoring operation was to train shore personnel to perform monitoring operations in a radiation area, to test radiac equipment under field conditions, and to develop a more effective passive defense organization.

At 1450 hours, when the Test Manager considered the area safe for test activities, Navy Passive Defense Teams left their stations to identify the 0.25 and 2.5 R/h isointensity territory in the shot area. Project personnel remained in this area for an undetermined time and then returned to Camp Desert Rock.

On 24 March, the day after the detonation, project personnel assembled equipment for a field exercise in rescue techniques. In the afternoon, personnel traveled by truck convoy to Area 10 where emergency rescue units were dispatched to predetermined locations to recover mannequins that had been placed in the area before the detonation. The objective of this operation was to determine the general condition of mannequins subjected to a detonation.

Project personnel spent 25 March at Camp Desert Rock, preparing equipment for the next day's field exercises. On 26 March exercises consisted of monitoring and rescue operations similar to those conducted on the 24th. The objective of these

operations was to provide information on radioactive decay in areas previously monitored. The time project personnel spent in the area is not known. On 27 March, project personnel departed for their permanent duty stations (54; 56; 58; 88; 105; 110).

Project 40.21, Ordnance Vehicular Equipment Test, was conducted by the Ballistic Research Laboratories. The principal participants were from the 573rd Ordnance Company, who placed the equipment with the assistance of the Detroit Arsenal. Ballistic Research Laboratories personnel from Military Effects Group Project 3.1 recorded blast pressure from gauges located on or near the test equipment, and Army Chemical Warfare Laboratory personnel from Military Effects Group Project 2.7 took radiation measurements. The objectives were to determine the effect of roll-over safety bars in minimizing damage to wheeled vehicles, to obtain experimental design data for the future development of ordnance equipment, and to investigate the shielding effect of armor against gamma radiation. The equipment was placed at various positions in the display area. The vehicles included three M48 tanks, one M59 armored personnel carrier, one T97 self-propelled gun, six 1/4-ton trucks, twelve 2-1/2-ton cargo trucks, and four 5-ton M54 trucks (102; 105).

2.2 DEPARTMENT OF DEFENSE PARTICIPATION IN MILITARY EFFECTS, SCIENTIFIC, OPERATIONAL TRAINING, AND SUPPORT ACTIVITIES AT SHOT ESS

In addition to the Exercise Desert Rock activities described in the previous section, Department of Defense personnel performed a variety of tasks during Shot ESS that required them to enter the forward area before, during, or after the shot. At 1450, two hours and 20 minutes after the detonation, the Test Manager declared the area safe to conduct recovery operations.

DOD personnel performed the 19 projects sponsored by the Field Command Military Effects Group and assisted in another two

test group projects sponsored by the Civil Effects Test Group (CETG). The Air Force conducted two operational training projects. In addition, support activities accounted for a number of DOD participants at Shot ESS. The Air Force Special Weapons Center (AFSWC) flew missions for the test groups and the Test Manager.

2.2.1 Department of Defense Participation in Military Effects Group Projects

The Military Effects Group conducted 19 projects at Shot ESS, as listed in table 2-3. Because in most cases, many of the same project personnel performed both pre- and postshot activities, estimates reflect the maximum number of DOD personnel who would have been involved in one aspect of the project. For example, if the project description states that 15 individuals performed preshot activities and five performed postshot recovery, the estimate listed in the table would be 15.

Project 1.2, Shock Wave Photography was fielded by the Naval Ordnance Laboratory. Two camera stations were located about 3,130 meters west and 4,380 meters southeast of ground zero to photograph the development and progress of the base surge produced by an underground nuclear detonation. Project personnel entered the area several days after the shot to recover film from the cameras (39; 75; 78; 88; 103).

Project 1.6, Crater Measurements, determined the physical characteristics, such as size and length, of the crater and lip formed by the underground nuclear detonation. A further objective was to define the extent of the "apparent crater" and "true crater."

In preparation for this shot, project personnel placed 21 vertical shafts of colored sand along one diameter through ground

Table 2-3: TEST GROUP PROJECTS WITH DEPARTMENT OF DEFENSE PARTICIPATION, SHOT ESS

Project	Title	Participants	Estimated Personnel
		Military Effects Group	
1.2	Shock Wave Photography	Naval Ordnance Laboratory	9
1.6	Crater Measurements	Ballistic Research Laboratories; Engineer Research and Development Laboratory	*
1.7	Underground Explosion Effects	Stanford Research Institute	6
2.1	Gamma Exposure versus Distance	Army Signal Corps Engineering Laboratories	*
2.3a	Neutron-induced Radioactive Isotopes in Soils	Naval Radiological Defense Laboratory	6
2.3b	Gamma Radiation Fields Above Fallout Contaminated Ground	Naval Radiological Defense Laboratory	6
2.4	Gamma Dose Rate versus Time and Distance	Evans Signal Laboratory	*
2.5.1	Fallout Studies	Chemical Warfare Laboratory; Army Chemical Center	44
2.5.2	Distribution and Intensity of Fallout from the Underground Shot	Naval Radiological Defense Laboratory	6
2.6	Radiation Energy Absorbed by Human Phantoms in a Fission Fallout Field	Naval Medical Research Institute	12
2.7	Shielding Studies	Chemical Warfare Laboratory; Army Chemical Center; Bureau of Yards and Docks; AFSWP	*
3.3.1	Flexible Measuring Devices and Inspection of Operation JANGLE Structures	Bureau of Yards and Docks	7
3.3.2	Behavior of Underground Structures Subjected to an Underground Explosion	Office, Chief of Engineers	3
6.1.1a	Evaluation of Military Radiac Equipment	Army Signal Corps Engineering Laboratories	*
6.1.2	Accuracy of Military Radiacs	Naval Radiological Defense Laboratory	6
6.3	Missile Detonation Locator	Army Signal Corps Engineering Laboratories	2
6.4	Test of IBDA Equipment	Wright Air Development Center	12
9.1	Technical Photography	Lookout Mountain Laboratory; AFSWC; Air Force Missile Test Center; EG and G	21
9.4	Atomic Cloud Growth Study	Air Force Cambridge Research Center; U.S. Weather Bureau; EG and G	*
		Civil Effects Test Group	
37.2	Phenomenology of Fallout at Near Distance	Air Force Special Weapons Center	*
39.6	Measurement of Initial Residual Radiations by Chemical Methods	Army Signal Corps Engineering Laboratories	*

* Unknown

zero. In October 1955, when the residual contamination had decreased to an acceptable level, excavation work began to uncover the colored-sand columns. The top of the central column, when uncovered, was 128 feet below the original ground level, or 61 feet below the center of gravity of the charge. This point defined the depth of the true crater, the crater before the material fell back in. The radius of the true crater was determined to be 50 meters. The apparent crater, the crater after the material fell back, was measured in considerable detail by aerial mapping techniques, using previously placed aerial markers. A bulldozer was used in the postshot excavation to uncover the sand columns (75; 78; 88; 94).

Project 1.7, Underground Explosion Effects, was designed to measure shock forces produced by an underground detonation. The experiment measured how much pressure was exerted on the soil, how much soil was moved, and how fast the soil moved.

Before the shot, six project personnel spent approximately two weeks installing 76 channels of instrumentation. Postshot recovery of data and gauges, which began when the residual contamination had decreased to an acceptable level, probably took three participants nine weeks (39; 75; 78; 88; 115).

Project 2.1, Gamma Exposure versus Distance, was designed to evaluate the gamma-radiation exposure potential at various distances from a nuclear detonation. The project involved the placement of 156 dosimeter stations in the shot area located 270 meters to farthest 16.2 kilometers from ground zero. Project 2.5.1 personnel worked with Project 2.1 personnel in placing and recovering the dosimeters. Recovery was to take place five to eight days after the detonation (46; 75; 78; 88).

Project 2.3, Gamma Ray Spectral Measurements, consisted of two parts: Project 2.3a, Neutron-induced Radioactive Isotopes in

Soils, and Project 2.3b, Gamma Radiation Fields above Contaminated Ground. The primary objective of Project 2.3 was to istinguish between the contribution to residual gamma radiation produced by neutron-induced radioactivity in the soil surrounding a nuclear detonation and radioactivity resulting from fallout.

Project 2.3a, Neutron-induced Radioactive Isotopes in Soils, studied the secondary gamma radiation induced in the surrounding soil by neutrons produced from the nuclear detonation. Project personnel included two recovery teams, each consisting of two personnel from Project 2.5.2 and a monitor furnished by the radiological safety support unit. After the detonation, when the Test Manager declared the area open for recovery operations, the teams, traveling in separate vehicles, went to stations south and east of ground zero to recover soil samples for Project 2.3a. The recovery parties obtained two soil samples, one from the base-surge region and the other from the fallout region. The e timated work-time at each station was between one and two minutes. After the samples were collected, they were sent to Project 2.3b personnel for analysis (39; 68; 75; 78; 88).

Project 2.3b, Gamma Radiation Fields above Fallout Contaminated Ground, was designed to study gamma radiation resulting from fallout on the soil surface surrounding a nuclear detonation. Data were obtained by project participants measuring postshot radiation levels near the point of detonation.

A project team from the Naval Radiological Defense Laboratory conducted Project 2.3b nine days after the detonation. The team traveled in a military truck from Camp Mercury to the vicinity of the crater to measure the radiation intensity. They entered the shot area on the main access road, where they stopped to examine two soil samples taken from the base-surge and fallout regions of the crater as part of Project 2.3a. Then the truck

continued to a main road southeast of ground zero until a hand-held survey meter indicated a radiation intensity of 0.3 R/h about 2,300 meters southeast of the crater. Project 2.3b personnel chose this location as the most suitable area for measuring radiation intensities. They positioned the truck so that they could survey terrain free of sagebrush.

The team spent about o e hour assembling their instruments for radiation field measurements. They were joined in their activities by another project participant who was given permission to enter the shot area to operate a spectrometer. The team began taking data readings at about 1335 hours on 1 April and finished at approximately 1720 hours. It is estimated that the dismantling process took an additional hour, after which the personnel returned to Camp Mercury. For the duration of their stay in the shot area, personnel wore full protective clothing, including gloves and respirators. The team was accompanied by two monitors from the 1st Radiological Safety Support Unit (39; 75; 78; 88; 99).

Project 2.4, Gamma Dose Rate versus Time and Distance, evaluated the neutron-induced gamma radiation hazard at various times after the detonation. Before the detonation, project personnel placed instruments at locations around ground zero where they would provide maximum information on the predicted downwind portion of the fallout field. They established two main instrument lines east and south of ground zero to cover the main axis of the predicted fallout pattern. In addition, they assembled several stations southwest and west to give a more complete picture of the fallout pattern. The station positions ranged from 270 meters to 5,500 meters from ground zero. The instruments were recovered as the radiation field decayed to lower intensities (45; 75; 78; 88).

Project 2.5.1, Fallout Studies, was conducted to study the radiation hazard posed by fallout. To accomplish the project objectives, personnel documented the radioactivity associated with base-surge fallout, cloud fallout, and the crater-lip areas following the detonation. Radiation fallout measurements were obtained by using four survey activities:

- Base-surge fallout and cloud-fallout sampling
- Aerial surveys
- Ground surveys
- Crater and crater-lip sampling.

For base-surge fallout and cloud-fallout sampling activities, Project 2.5.1 personnel used various land and above-ground aerial survey instruments to record radiation intensities in the areas around ground zero. In addition, air samplers were placed to establish the amount of airborne contamination around ground zero after the detonation.

Before the shot, project personnel positioned 21 fallout collectors at distances of 270 to 9,900 meters northeast to southwest of ground zero. They also installed air-sampling instruments at two locations more than 630 meters southwest and southeast of ground zero.

The expected base-surge area for the detonation extended about 1,450 meters from ground zero. Consequently, the fallout collectors situated on trailers within 1,450 meters of ground zero were attached to long cables to facilitate early sample recovery in highly radioactive areas. Following the detonation, when recovery operations were permitted, teams of three project personnel drove vehicles to recover the trailers holding the fallout collectors. The teams traveled to the end of the trailer cable lines, attached the cables to their vehicles, and pulled the trailers into areas of lower radioactivity, where recovery

parties removed the samples from the fallout collectors. Project personnel retrieved 15 of the fallout collectors within six hours of the detonation and the remaining instruments on the day after the detonation.

Aerial survey activities began two hours after the detonation when helicopters with aerial radiation survey instruments measured the radiation intensity in the crater, in the lip, and in the fallout area. Two and three hours after the detonation, two H-19 helicopters, each carrying a crew of four project personnel and a radiological safety monitor, began surveying radiation intensities in the fallout areas around the crater. Each helicopter team surveyed about 75 preselected locations. These aerial surveys were accomplished by using a survey probe suspended slightly above the ground from the end of a cable. The radiation measurement was then recorded. Before moving to the next point, the operator in the hovering helicopter reeled in a few feet of cable. The probe was again lowered to take a reading at the next location. Another gamma radiation survey meter monitored the radiation inside the helicopter.

These aerial surveys were conducted from an altitude of 500 to 800 feet above the ground depending upon the radiation intensity within the aircraft. This method of locating dose-rate contours on the ground was developed to cover large areas in minimal time and reduce the radiation exposure to project personnel. In general, aerial surveys were planned for those areas where the ground intensity was greater than 10 R/h.

In addition to the project personnel described above, another helicopter survey party was scheduled to fly about 1,000 feet above the crater and lower a recording-type survey meter into the center of the crater by means of a rope. Also, a sample of the crater was to be taken in a pail suspended at the end of a 370-meter line. The soil sample was to be carried to the

radiological safety checkpoint and transferred to a vehicle. However, it is believed that this additional aerial survey was canceled because of high radiation levels at the crater following the detonation (39; 75; 78; 88; 118).

Ground surveys of radiation-intensity levels were conducted in separate portions of the expected fallout area two hours after the detonation. After orientation by Project 2.5.1 personnel, seven survey crews from the 50th Chemical Service Platoon of Camp Desert Rock were assigned sections of the station array. One crew was directed to begin the survey on the 160-degree azimuth at the most distant station from ground zero, to proceed toward ground zero until an exposure of 0.3 roentgens had been accumulated, and then to return. In like manner, crews were assigned to stations on the 60, 80, 100, 120, and 140-degree azimuths. The seventh crew was directed to upwind and crosswind stations; beginning with those stations 3,250 meters from ground zero, that crew then moved in toward ground zero.

To record background radiation levels in the area and become familiar with the terrain, the crews began practice surveys six days before the detonation and completed three surveys before the shot. Each party of two to four project personnel operated two calibrated gamma-radiation survey instruments from a jeep. The crew stopped at each station location, left their vehicle, and made two radiation-intensity readings three feet above the ground. Extra personnel were assigned to each crew to ensure that replacements would be familiar with the route. Before the surveys began, each station was marked with two colored flags and a painted and numbered sign to ensure that the survey crews would record the correct station on their data sheets.

Additional ground-survey data were obtained by recovery teams who entered the area at intervals of two and 24 hours after the detonation to recover samples and instrument records. These

recovery teams used survey meters to make gamma-radiation intensity measurements at the instrument stations.

For crater and crater-lip sampling, Project 2.5.1 personnel remained at the NTS after the detonation to recover surface and core samples from the lip of the crater. Three project personnel wearing protective clothing and respirators took samples on 31 March, 1 April, and 27 June. These participants used core samplers, each consisting of two pieces of telescoping tubing approximately 1.2 meters long. A sharp steel point was attached to the bottom of the outside of the tubing to facilitate ground penetration (39; 75; 78; 88; 118).

Project 2.5.2, Distribution and Intensity of Fallout from the Underground Shot, had two objectives. The first was to determine how the material and radioactive debris thrown up by the underground detonation were distributed around ground zero. The second objective was to investigate and evaluate the intensity of fallout from the event by sampling the fallout at ground level. Project personnel associated with Project 2.5.2 coordinated their work with Project 2.5.1. Except for some soil samples taken after the event, fallout samples were taken by capturing debris and materials as they fell to the ground immediately after the detonation.

Most samples were collected in steel buckets installed in the field singly, in pairs, or in multiple arrays. The multiple arrays were placed southeast of ground zero. The shot was delayed until it was certain that fallout would go in that direction. A second type of fallout collector, gummed paper, was mounted next to these collectors at all locations. A third type of sampling instrument, called incremental collectors, had a number of compartments that opened and closed in sequence and at measured intervals of time. These collectors provided information on the particulate nature and the arrival rate of fallout after a detonation.

One month before the test, project personnel installed the instruments used in this experiment. They activated the instruments within 48 hours before shot-time. Three and one half hours after the detonation, two teams in vehicles recovered samples at two stations located along the 100-degree and 180-degree azimuths at unknown distances from ground zero. Each recovery team, consisting of two project personnel and one radiological safety monitor, spent approximately one minute at each station. They delivered one sample from each location to Project 2.3 personnel for analysis. The other two samples were flown to the Naval Radiological Defense Laboratory within ten hours of the detonation for decay and radiochemical studies.

Remaining samples or sampler instruments were recovered during the seven days following the detonation. Times and dates of all recoveries and conditions of sampling duties were recorded. These samples were shipped by the earliest available aircraft to the Naval Radiological Defense Laboratory for measurement and study (39; 75; 78; 88; 121).

Project 2.6, Radiation Energy Absorbed by Human Phantoms in a Fission Fallout Field, measured radiation intensities of fallout by placing masonite mannequins instrumented with radiation detectors at various stations within the fallout field at various times following detonation.

At 1450 hours on 23 March, the time designated by the Test Manager for recovery operations to begin, two teams, each consisting of four project personnel and a radiological safety monitor in two vehicles, placed mannequins at two stations located 2,790 meters southeast of the crater near the 0.5 R/h line, as shown in figure 2-3. It is estimated that the teams spent 10 to 15 minutes in the fallout field. On each of the next three days, project personnel made three separate trips into the area to check instrumentation and collect data.

Figure 2-3: PROJECT 2.6 PERSONNEL PLACE MANNEQUIN TO COLLECT DATA ON RADIATION AND ITS CONTRIBUTION TO BODY DOSE

On 24 March, project personnel established two more mannequin stations at locations 570 and 630 meters south of the crater. The gamma radiation intensity readings at these two locations were 2.3 and 2.4 R/h, respectively. On 25 March, a fourth station was established at a distance of 470 meters south of ground zero, where the gamma radiation intensity was 2.3 R/h (65; 75; 78; 88; 97).

Project 2.7, Shielding Studies, was designed to evaluate the effectiveness of structures and equipment in reducing gamma and neutron radiation hazards. Reinforced concrete shelters and underground shelters were tested in the ESS shot area. Project personnel instrumented all of these shelters before the shot with gamma-radiation film detectors. In addition to the shelters, they instrumented two foxholes, located 1,500 meters southeast of ground zero, for combined initial and residual gamma-radiation measurements. Project personnel recovered records from various structures and field fortifications two days after ESS. In addition, both foxholes were monitored at various depths and on top of the ground a few days after the detonation (29; 39; 75: 78; 88; 133).

Project 3.3.1, Flexible Measuring Devices and Inspection of Operation JANGLE Structures, was performed to study the effects of the underground detonation on above-ground steel and concrete structures. The data were used to assess the destructive potential of the blast and shock loading created by the demolition munition on the buildings. To perform this experiment, 15 steel and concrete structures were built in an arc at a range of 90 meters around ground zero and instrumented by project personnel. Several structures remaining from the 1951 BUSTER-JANGLE Series located within 310 meters of ground zero were also instrumented and inspected before and after the detonation to determine the damage caused by blast and shock loading.

Preshot preparations for Project 3.3.1 probably took six participants two weeks. Postshot recovery of data probably took four personnel, including a bulldozer operator, one week beginning sometime after the area was declared open for recovery operations.

The postshot inspection of the Operation BUSTER-JANGLE structures probably took five individuals, including a motion-picture photographer and a still photographer, four days (32; 39; 75; 78; 88).

Project 3.3.2, Behavior of Underground Structures Subjected to an Underground Explosion, studied the effects of shock loading produced by an underground detonation on buried structures by measuring earth pressure and movement produced by the shock wave. Results were correlated with data obtained from previous tests of conventional high-explosive charges and from Shot UNCLE, an underground nuclear event in Operation BUSTER-JANGLE conducted at the NTS in late 1951.

Two reinforced concrete structures were built below ground for this project. Three project personnel spent about one week completing the instrumentation. Aerial observation soon after the detonation disclosed that the Project 3.3.2 structures were completely covered by base-surge from the crater and could not be located. Primarily because of residual radioactivity, postshot examination of the structures was not conducted until October 1955, seven months after the shot, when radiation levels had decayed substantially (75; 78; 88; 120).

Project 6.1.1a, Evaluation of Military Radiac Equipment, field-tested six models of radiation detection instruments at Shot ESS. Personnel tested two of the instruments by comparing the new instruments with instruments currently in use to check their accuracy (15; 75; 78; 88).

Project 6.1.2, Accuracy of Military Radiacs, was designed to measure the accuracy of standard military radiation detection equipment. A second objective was to measure the directional properties of typical radiation fluences following a nuclear detonation.

Five participants and a radiological safety monitor were stationed at BJY from three hours before shot-time to 30 minutes after the detonation, when they proceeded in three vehicles north to the 4 R/h line and spent an estimated ten minutes placing directional radiation instruments on an automatic scan. They made three five-minute trips to the area later on shot-day, apparently to read the radiation instruments.

With the prior authorization of the Test Manager, other project personnel entered fallout areas as early as 40 minutes after shot-time. Their entry was followed by other entries into the fallout area at one, two, and five hours after the detonation. On the first trip, project personnel followed the initial radiological survey team to an area registering 3 R/h, where they stopped to conduct readings on 25 instruments of five different types.

At all times when crews were carrying out operations in radiation areas, extra vehicles were provided. Team operations were observed from outside the radiation area through field glasses, so that assistance could be provided in any emergency (39; 75; 78; 88; 129).

Project 6.3, Missile Detonation Locator, was designed to test the feasibility of a tactical range detonation-locator system. The system was designed to locate the point of a nuclear detonation by detection and analysis of the electromagnetic radiation emitted.

The detonation locator consisted of broad-band receivers set up on baselines in California, approximately 110 and 320 kilometers southwest of the NTS. Radio links between the stations provided the time comparisons necessary to determine relative times of arrival of the electromagnetic pulse at each station. Crystal clocks were used for accurate time-of-arrival analysis.

Four hours before the detonation, two project participants proceeded to a station located onsite and approximately two kilometers north of the Control Point, at UTM coordinates 830901. They operated the station through shot-time, obtaining baseline data on the time of arrival of the electromagnetic pulse. The time of their return to the Control Point area is not known, although it was estimated to have been little more than an hour after the detonation (39; 75; 78; 88; 101).

Project 6.4, Test of IBDA Equipment, was designed to gather engineering evaluation data for an Indirect Bomb Damage (IBDA) system installed in a B-50D aircraft. The IBDA system consisted of standard radar set, AN/APQ-24; a bomb-damage evaluation group, AN/APA-106 (XA-1); a light and time recording set, AN/ASH-4 (XA-1); and a K-17 aerial camera.

The B-50D staged out of Kirtland Air Force Base (AFB) and normally had a crew of ten. Since engineering evaluation tests were being conducted, one additional engineer and one technician accompanied the crew to monitor and ensure the operation of the IBDA system. The B-50D, which was positioned by radar navigation, simulated an aircraft delivering a nuclear bomb. At shot-time, the B-50D was located at an altitude of 25,000 feet, from seven to 13 kilometers from ground zero (28; 35; 39; 75; 78; 88).

Project 9.1, Technical Photography, was designed to provide documentary photographs of the detonation. The project involved both a ground-photography mission and an air-photography mission.

To conduct the ground-photography mission, project personnel arrived at three camera stations, located at UTM coordinates 780959, 755042, and 768057, at 0600 hours on shot-day, six hours before the detonation. Five individuals occupied each of the three stations, remaining there through shot-time. Current research indicates that they returned to the Control Point area about one hour after the detonation.

In conducting the air-photography mission, Project 9.1 personnel took documentary photographs of the detonation from an RC-47 aircraft that took off from Indian Springs AFB. This RC-47, which was provided by the Air Photographic and Charting Service, flew at an altitude of 8,000 to 10,000 feet, 10 to 16 kilometers southeast of ground zero. The RC-47 had a crew of three, plus an estimated two or three photographers. The aircraft also conducted cloud growth photography for Project 9.4 (33; 35; 75; 78; 88).

Project 9.4, Atomic Cloud Growth Study, was designed to study the development of the cloud produced by a nuclear detonation. Data on the rate of cloud rise and maximum cloud height were obtained from instruments located at the Control Point (35; 48; 75; 78; 88).

2.2.2 Department of Defense Participation in CETG Projects

The CETG conducted several projects at ESS, but only two involved DOD personnel, as shown in table 2-3.

Project 37.2, Phenomenology of Fallout at Near Distance, studied the downwind concentrations of airborne and fallout activity in relation to distance from ground zero. DOD involvement in the project consisted of an AFSWC aircrew flying a C-47 aircraft, which provided an airborne radio relay. The aircraft flew in a pattern 15 to 95 kilometers downwind from the

NTS between five hours before shot-time and three hours after the detonation. The aircrew provided radio communications with ground personnel of Project 37.2, who were performing fallout studies at locations about 15, 30, and 55 kilometers east of the NTS. This aircraft was one of two terrain-survey aircraft discussed in the AFSWC section of this chapter, section 2.2.4 (21; 35; 75; 88).

Project 39.6, Measurement of Initial Residual Radiations by Chemical Methods, was designed to obtain dosimetric data at stations where various biological investigations were being conducted. The positioning of stations at ESS is not known. Project personnel were scheduled to place dosimetric instruments the day after the shot and recover them 24 hours later (21; 75; 88; 123).

2.2.3 Department of Defense Operational Training Projects

Two operational training projects were conducted at Shot ESS:

- Project 40.3, Crew Indoctrination
- Project 40.6, Calibration of Electromagnetic Effects.

Project 40.3, Crew Indoctrination, was developed to train Tactical Air Command aircrews in the effects of a nuclear detonation while flying simulated tactical delivery techniques and flyby maneuvers. Eight F-84 aircraft, each with one pilot, participated in this project. These aircraft, operating out of George AFB, California, flew simulated low altitude bombing exercises and dive bombing maneuvers over the NTS at the time of the detonation. The aircraft performed these maneuvers two miles from the nuclear cloud. They could not approach the cloud any closer because of high radiation intensities within the cloud. About ten minutes after the detonation, at 1240 hours, the aircraft begar their return to George AFB.

At 0615 hours, ten personnel in two vehicles occupied four positions in Yucca Flat, about eight kilometers north of the Control Point, at UTM coordinates 806960, 823960, 838960, and 862960. From 20 minutes before until five minutes after the detonation, they fired smoke grenades and smoke generators to serve as guide markers for Project 40.3 aircraft (7; 8; 35; 36; 37; 38; 88; 105; 122).

Project 40.6, Calibration of Electromagnetic Effects, was designed to measure the characteristics of the electromagnetic pulse created by the detonation. Project personnel were required to occupy several permanent stations at various distances from ground zero during the detonation. At 0900 hours on the day before the shot, three men flew in a helicopter to station 40.6b on Yucca Lake, 24 kilometers south of ground zero. In about four hours, they had serviced eight sets of unmanned recording equipment. On shot-day, five participants operated equipment at station 40.6b during the detonation and for two hours after shot-time. Project personnel then recovered data from within their station and left for Camp Mercury to evaluate project results (88; 106).

In addition to these two operational training projects, a B-17 aircraft with an estimated crew of ten was used to carry official observers who witnessed the shot from the air. This aircraft was not part of any official operational training project (3; 35; 88; 105).

2.2.4 Air Force Special Weapons Center Activities

AFSWC support consisted of a cloud-tracking mission, courier flights of soil samples, and an aerial survey of terrain. No cloud samples were taken following the ESS detonation. Experience had indicated that internal damage to the engines of sampler aircraft could result if the aircraft had flown through the dirt and debris produced by a subsurface detonation (35).

Cloud Tracking

Immediately after the detonation, a B-25 aircraft from Indian Springs AFB flew a cloud-tracking mission. The aircraft, with an estimated crew of five, flew at 17,000 feet in a east-southeasterly direction north of U.S. Route 95. The B-25 tracked the cloud to a point north of Glendale, Nevada. Visual tracking of the cloud was easy, because it contained a large amount of soil debris (35; 38).

Courier Service

After the ESS event, four aircraft transported soil samples to various airbases for delivery to project laboratories for analysis. The first courier aircraft, a C-119, left Indian Springs AFB at 1920 hours on 23 March for Hamilton AFB, California, with samples for the Naval Radiological Defense Laboratory. A C-47 left Indian Springs AFB at 0020 hours on 24 March for Friendship International Airport, Maryland, with samples for the Chemical Warfare Laboratory and Project 2.5, Fallout Studies. A B-25 left Indian Springs AFB at 1207 hours on 25 March 1955, for McClellan AFB, California, with samples for the Air Force. At 1231 hours on 25 March, a C-47 left Indian Springs AFB for Friendship International Airport with samples for the Chemical Warfare Laboratories (35; 38).

Aerial Surveys of Terrain

As directed by the Test Manager and Test Director, four AFSWC H-19 helicopters and two AFSWC C-47 aircraft flew radiological safety and aerial surveys of terrain following the ESS detonation to assess detonation damage and record radiation intensities. At an unknown time after the detonation, one C-47 performed a low-level survey, flying at an altitude of 300 to 500 feet. The second C-47 served as a relay station for ground radiological surveys conducted by personnel of CETG Project 37.2, Phenomenology of Fallout at Near Distances. The survey aircraft followed the same route as the cloud-tracking aircraft (35; 38).

2.3 RADIATION PROTECTION AT SHOT ESS

The purpose of the various radiation protection procedures developed for Operation TEAPOT was to ensure that individual exposure to ionizing radiation was as low as possible, while allowing participants to accomplish the operational requirements of each activity. Some of the procedures described in the Series volume resulted in records, such as film-badge listings and isointensity plots, which enabled Exercise Desert Rock, the Joint Test Organization (JTO), and AFSWC to evaluate the effectiveness of their procedures. Such records for ESS have been located only for the JTO. The JTO Onsite Radiological Safety Organization was staffed by the Army 1st Radiological Safety Support Unit, from Ft. McClellan, Alabama, and was managed by AFSWP. The JTO information presented in this section includes film-badge data, logistical data on radiological safety equipment, survey results and records, isointensity maps, and decontamination records. Other than the Final Dosage Report, no indication of Exercise Desert Rock VI or AFSWC radiological safety activities have been located.

Dosimetry Records

From 23 March to 27 March 1955, 871 Film badges and 471 pocket dosimeters were issued. Film badge readings indicate that by the end of this period, 34 personnel received cumulative exposures between 2.0 and 3.9 roentgens. An additional three individuals accumulated exposures greater than the JTO-authorized limit of 3.9 roentgens, and were excluded from entry into radiation areas for the remainder of Operation TEAPOT (16; 19).

One of the three individuals was a member of the 644th Troop Carrier Squadron, a helicopter pilot with the Test Aircraft Branch at Indian Springs AFB. This individual, whose activities are not known, received an exposure of 3.97 roentgens at Shot ESS, which resulted in a total exposure of 4.02 roentgens for Operation TEAPOT (17; 18).

The second individual, who was a member of the Chemical and Radiological Laboratory, participated in Program 2 at ESS. He had a total exposure of 4.50 roentgens by the end of shot-day (16; 18). This man operated the radiation-detecting probe used in the radiological safety helicopter survey of ground zero.

The third individual with an exposure greater than 3.9 roentgens was a civilian from Evans Signal Laboratory who received an exposure of 1.7 roentgens at Shot ESS, which resulted in a total exposure of 4.3 roentgens (17; 18). The specific activities of this third individual are not known.

Logistical Data for Radiological Safety Equipment

For Shot ESS, the General Supply Section issued 1,812 pieces of protective clothing and 301 respirators. In addition, the Instrument Repair Section issued 382 radiacs (19).

Monitoring Activities

At 0730 hours on shot-day, the initial survey teams, road patrols, and checkpoint personnel left the Control Point, assembling at BJY to await the planned 0900 ESS detonation. After numerous delays in shot firing, the teams returned to the Control Point, but reassembled at the intersection at 1110 hours. Immediately after the detonation at 1230 hours, nine teams of two men each, left the Control Point for each of the nine stake lines. By 1300 hours, all checkpoints were established, and the initial survey crew had posted warning signs. The main checkpoint was located at BJY. The survey was delayed until 1310 hours because of the dust thrown into the air by the detonation. By 1450 hours, the initial survey was completed.

A copy of the initial isointensity map is shown in figure 2-4. The map shows an irregularity of the 0.01 and 0.1 R/h areas to the southwest caused by residual radiation from Shot TESLA, detonated on 1 March. Resurveys of the crater and surrounding

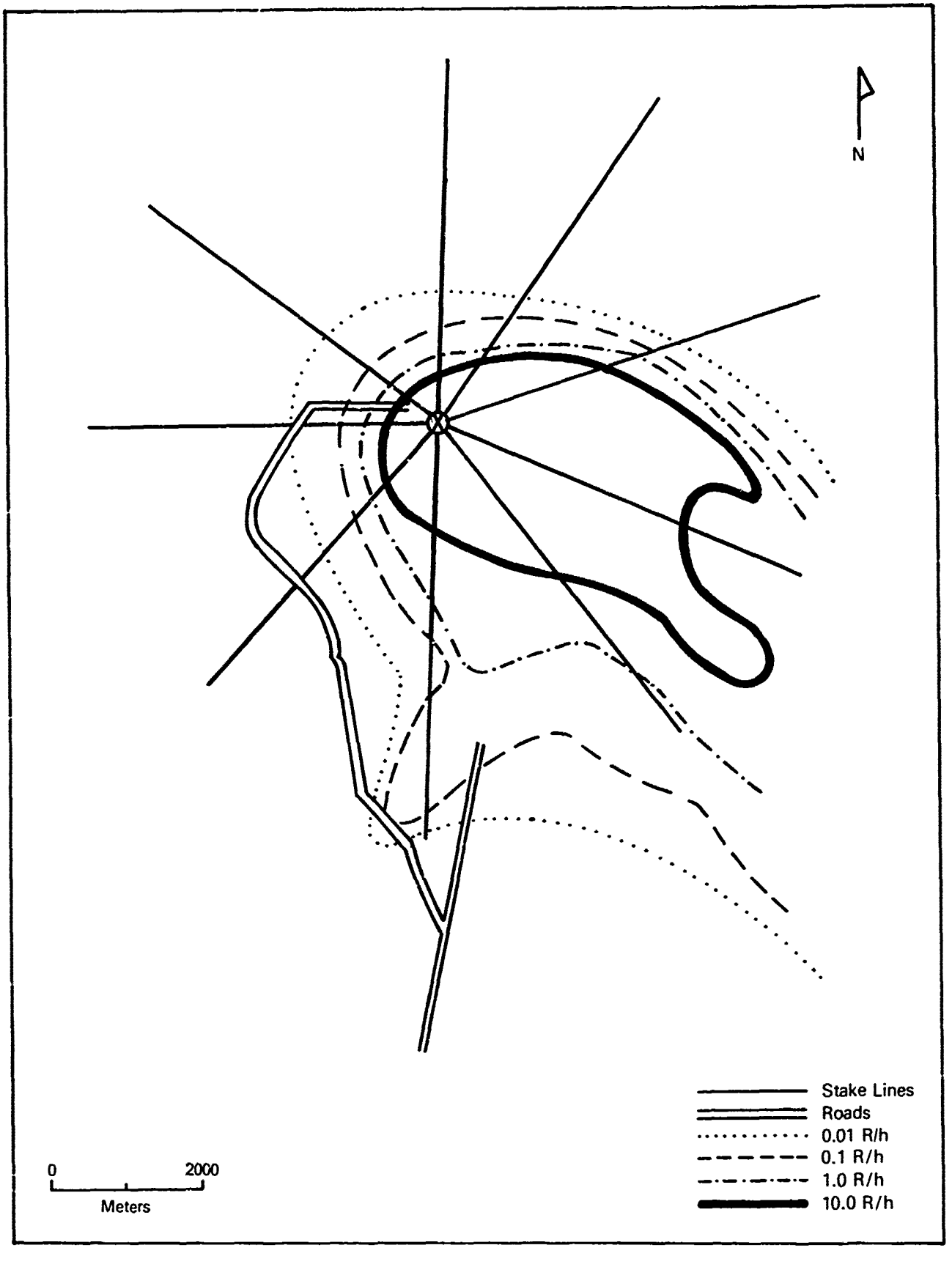


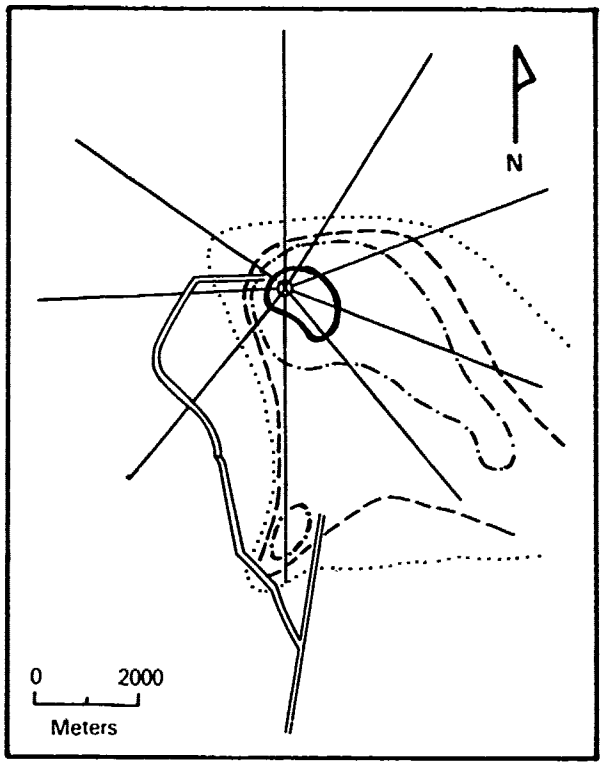
Figure 2-4: INITIAL SURVEY FOR SHOT ESS, 23 MARCH 1955, 1310 TO 1450 HOURS

areas were conducted on 24, 26, and 30 March, on 6, 12, and 21 April. and on 4 May. Copies of the isointensity maps generated from the resurveys of 24, 26, and 30 March and 21 April are shown in figure 2-5. The average exposures received by personnel of the survey teams entering the shot area on the initial survey and first resurvey were 0.82 and 0.48 roentgens, respectively (19).

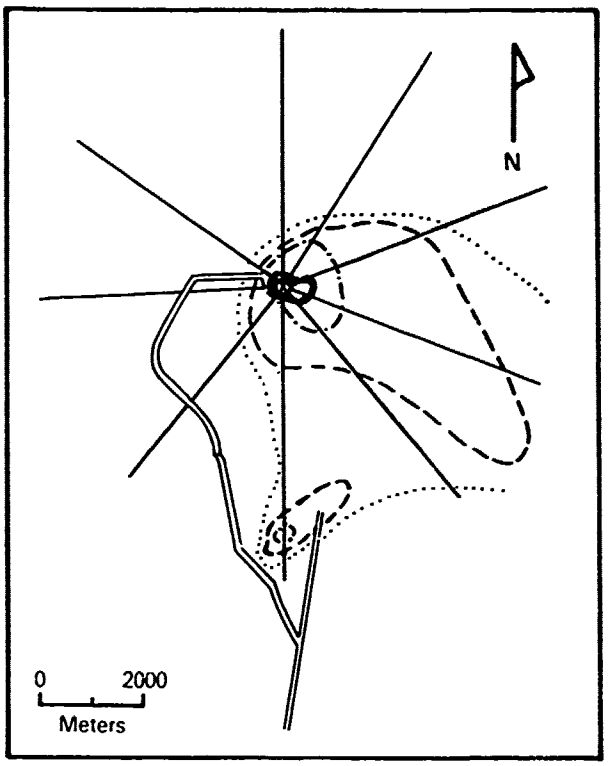
Two five-man helicopter crews were also trained for radiological surveys at ESS. The first crew, which left the pad near the Control Point ten minutes after the detonation, conducted a low-altitude survey in the northern and western portions of the shot area. Using a probe and cable system, the crew determined that fallout did not occur to the north and west of the test site, but that it formed a pattern in the mountainous terrain to the southeast of ground zero. The highest reading encountered during the survey was 70 R/h, about 2,290 meters southeast of ground zero. The height at which this reading was taken is not known.

After circling the test area, this helicopter proceeded to the BJY intersection, where a second crew took over to survey ground zero. This survey started about two kilometers northwest of ground zero, at 1425 hours. As the probe from the helicopter reached a point about 800 meters from ground zero and 300 feet above the ground, the reading was 200 R/h. With the probe 300 feet above the crater, the intensity was 1,000 R/h at 1428 hours. Readings were also taken at other locations in and around the crater. About 25 feet above the west end of the crater, the intensity was 2,000 R/h at 1437 hours.

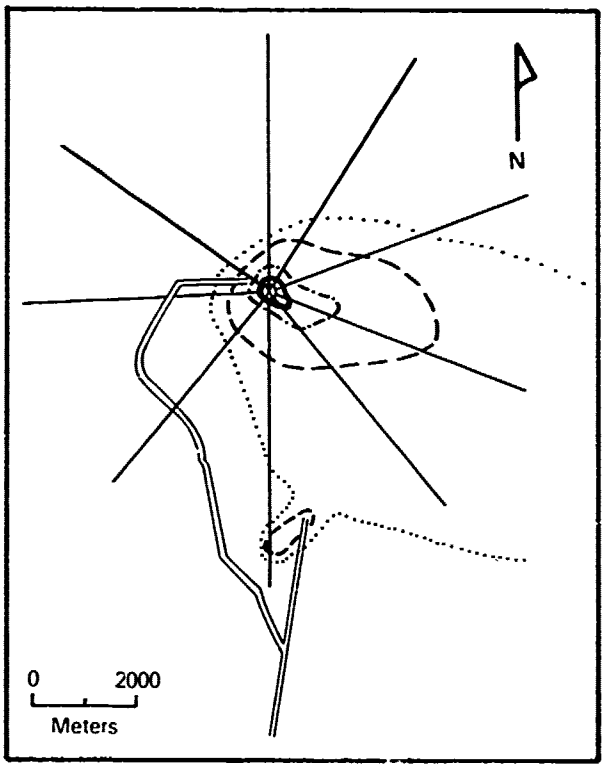
In addition to its survey work, the Monitoring Section provided monitors to a number of projects conducting recovery operations on shot-day. The assignments of these radiological safety monitors are summarized below (19).



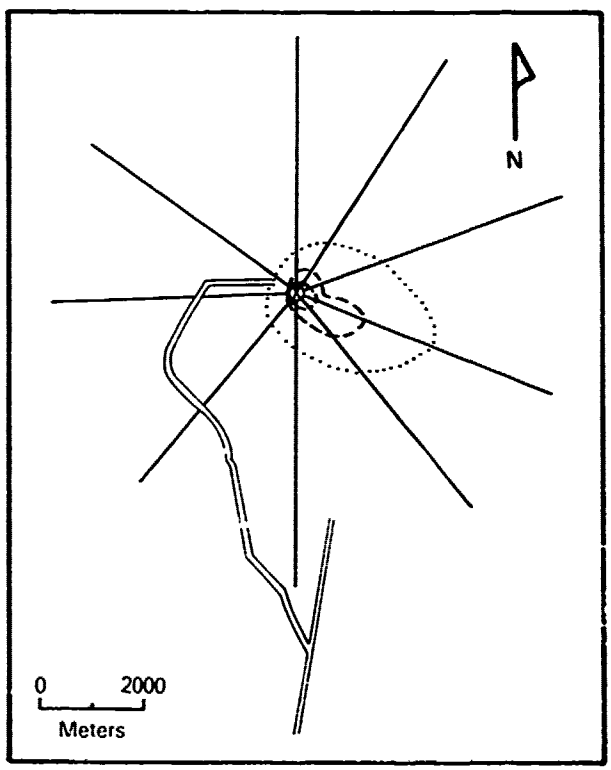
24 March 1955, 0630 to 0830 Hours



26 March 1955, 0645 to 0800 Hours



30 March 1955,



21 April 1955

Stake Lines
Roads
0.01 R/h
0.1 R/h
1.0 R/h
10.0 R/h

Figure 2-5: RESURVEYS FOR SHOT ESS

PROJECT	NUMBER OF MONITORS
2.3	2
2.5.1	3
2.5.2	2
2.7	1
6.1.2	1
30.3	1

The Monitoring Section also provided one monitor for a security party.

Recovery and Re-entry Procedures

The Plotting and Briefing Section cleared 14 parties for entry into the shot area on 23 March. On the days following Shot ESS, parties entered the shot area as follows (19; 75).

DATE	NUMBER
24 March	17
25 March	14
26 March	9
27 March	2
28 March	7
29 March	2
30 March	7
31 March	8
1 April	1
2 April	4
4 April	3
5 April	2
6 April	1
7 April	2

Decontamination

During the period covering Shot ESS, 23 March to 27 March, 105 project participants were sent to the personnel decontamination station after being monitored at the main checkpoint. Of these, 70 were considered contaminated, and 42 required decontamination by showering. For the latter, the most frequent locations of contamination were at exposed parts of the body, such as the nostrils, sideburns, and necks of these 42 participants. The other 28 individuals were decontaminated by removing contaminated clothing, washing, and applying masking tape to localized contaminated skin areas (19).

During the same period, 23 to 27 March, members of the Vehicle and Equipment Decontamination Section decontaminated 101 vehicles and 115 pieces of equipment. To allow the contamination to decay, they placed an additional 21 items of equipment in the hot park, an isolated area set aside for contaminated equipment (19).

The large number of individuals and equipment requiring decontamination was probably caused by the high concentration of radioactive material in the dirt-laden base surge that was produced by the subsurface detonation.

APPLE 1

SHOT SYNOPSIS

AEC TEST SERIES:	TEAPOT
DOD EXERCISE:	Desert Rock VI
DATE/TIME:	29 March 1955, 0455 hours
YIELD:	14 kilotons
HEIGHT OF BURST:	500 feet (tower shot)

Purpose of Test: To test a nuclear weapon for possible inclusion in the nuclear arsenal.

DOD Objectives: (1) To study the effects of a nuclear weapon on military equipment
(2) To allow DOD personnel to observe a nuclear detonation.

Weather: At shot-time, the temperature at shot height was 9.3° C.; pressure at 852 millibars; surface winds were calm; 19 knots from the south at 10,000 feet; 34 knots from the west at 20,000 feet; and 46 knots from the west at 30,000 feet.

Radiation Data: Onsite fallout of 10.0 R/h was detected during the initial survey, taken from 0527 to 0640 hours. The fallout was detected around ground zero and extended northeast.

Participants: Atomic Energy Commission, Exercise Desert Rock participants, Armed Forces Special Weapons Project, Air Force Special Weapons Center and other Air Force personnel, Los Alamos Scientific Laboratory, University of California, Federal Civil Defense Administration, contractors, DOD laboratories.

CHAPTER 3

SHOT APPLE 1

Shot APPLE 1, the eighth nuclear test of Operation TEAPOT, was detonated on 29 March 1955 at 0455 hours in Area 4 of the Nevada Test Site (NTS), at UTM coordinates 797056. A developmental device designed by the Los Alamos Scientific Laboratory, APPLE 1 was fired from a cab at the top of a 500-foot steel tower, and had a yield of 14 kilotons (30). The nuclear cloud top rose to an altitude of about 32,000 feet and proceeded east-northeast from the point of detonation. Onsite fallout was generally to the northeast of ground zero. The detonation lofted base-surge dust that obscured the shot area and persisted for three hours, until about 0800 hours (41; 70).

Department of Defense participants at Shot APPLE 1 took part in Exercise Desert Rock activities, scientific and military effects experiments, and support missions, as described in this chapter. Figure 3-1 depicts the location of DOD project personnel in the forward positions at shot time. An account of the radiological situation after Shot APPLE 1, along with the procedures used to minimize the exposure of DOD participants to ionizing radiation, is summarized at the end of the chapter.

3.1 EXERCISE DESERT ROCK VI OPERATIONS AT SHOT APPLE 1

Desert Rock exercise and support troops took part in three troop orientation and indoctrination projects, one troop test, and three technical service projects. Camp Desert Rock personnel also observed the shot, but they were not part of a numbered project. Table 3-1 lists Desert Rock VI activities at APPLE 1, presenting the numbers and titles of the programs and projects, the project sponsors, the numbers of DOD participants, and the service units involved in the projects.

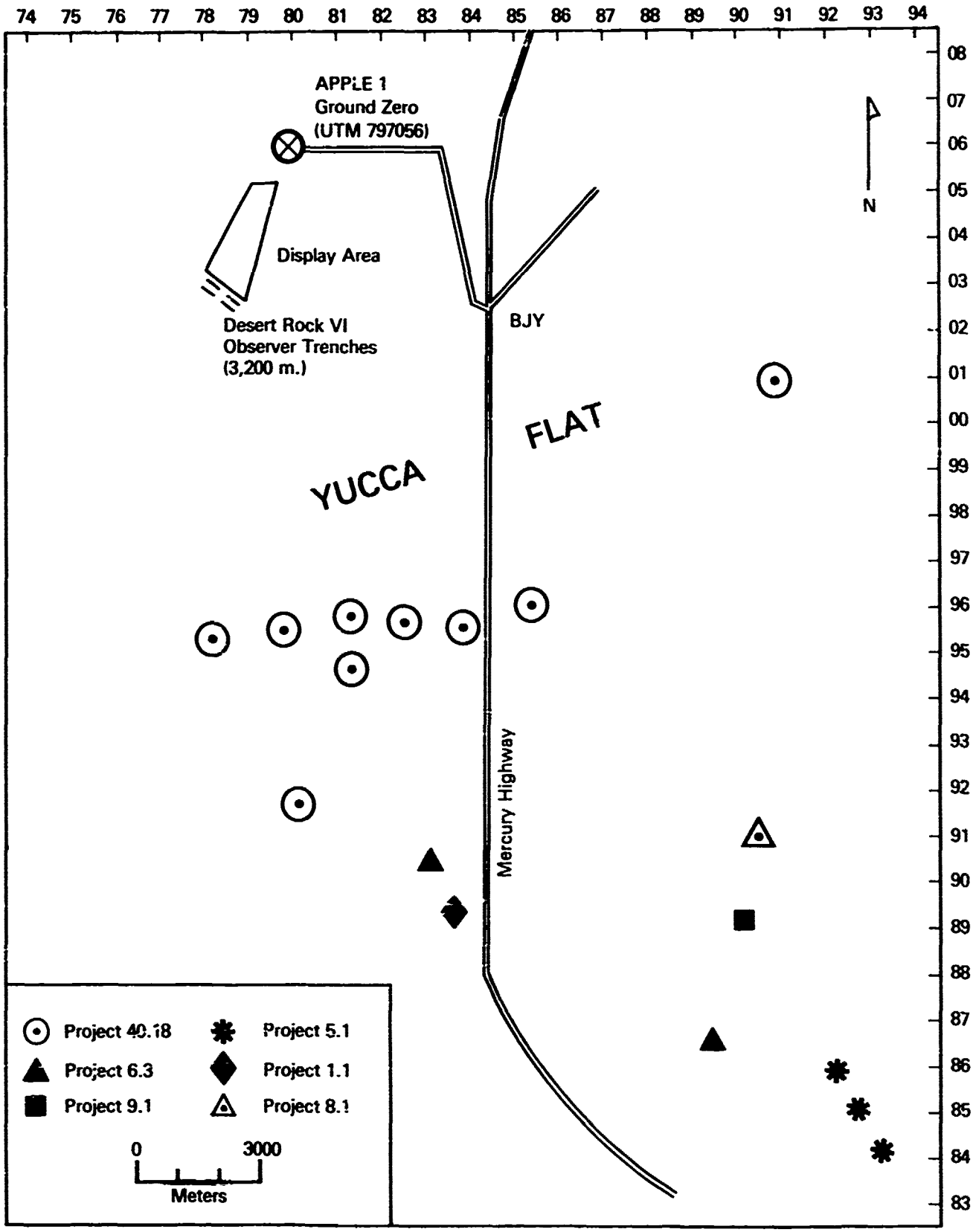


Figure 3-1: FORWARD POSITIONS OF DOD PERSONNEL AT SHOT-TIME FOR APPLE 1

Table 3-1: EXERCISE DESERT ROCK VI PROJECTS, SHOT APPLE 1

Program Type	Project	Title	Participants	Estimated DOD Personnel
Troop Orientation and Indoctrination	41.3	Army Observers	Army	13
	41.4	Navy Observers	Navy	2
	40.11	Marine Observers	Marine Corps	28
	–	Camp Desert Rock Observers	Camp Desert Rock Support Troops	550
Troop Test	40.18	Location of Atomic Bursts	Battery C (-) 532nd Field Artillery (Observation) Battalion	
Technical Service	40.19	Sixth Army CBR Defense Team Training	Sixth Army	24
	40.21	Ordnance Vehicular Equipment Test	Ballistic Research Laboratories; 573rd Ordnance Company; Detroit Arsenal; Chemical Warfare Laboratory	*
	–	Damage Effects Evaluation	Camp Desert Rock Support Troops	*

*Unknown

3.1.1 Troop Orientation and Indoctrination Projects

Three troop orientation and indoctrination groups and a group of Camp Desert Rock support troops, not assigned to a numbered project, took part in the Troop Orientation and Indoctrination Program at APPLE 1. All observers took part in the same orientation and training activities for the event.

The observers visited the shot area the day before the detonation, to conduct a preshot inspection of the equipment display. On shot-day, the observers arrived at the shot area at 0325 hours, about 90 minutes before the detonation. The preshot activities included an orientation and checks for safety, communications, and security. At 0355 hours, one hour before the detonation, the participants entered the observer trenches located about 3,200 meters south-southwest of the shot-tower. About 20 minutes after the detonation, the observers began the tour of the equipment display area situated between 2,250 and 900 meters southwest of ground zero. After inspecting the equipment damage, as shown in figure 3-2, the observers returned to the loading area located about 1,800 meters from the APPLE 1 ground zero. They boarded buses at 0615 hours to return to Camp Desert Rock (43; 54; 55; 57).

3.1.2 Troop Test

One troop test, Project 40.18, Location of Atomic Bursts, was conducted at Shot APPLE 1. The project, which was sponsored by The Artillery School, employed 4 participants from Battery C (-), 532nd Field Artillery (Observation) Battalion. The objectives were to test equipment and train troops in locating and determining the yield of a nuclear detonation. To perform the project, participants conducted field surveys using AN/TVS-1 cameras, MK-11 Bhangmeters, AN/MPQ-21X radar sets, and sound microphones. Project personnel manned nine survey stations approximating the typical deployment of an observation battery

Figure 3-2: ARMY OBSERVERS EXAMINE DAMAGED VEHICLE AFTER APPLE 1

under tactical conditions. The stations were at the following locations (83):

STATIONS	UTM COORDINATES
Station [Location 7]	800915
Station Location 6	782951
Station Location 5	798951
Flash Control Point	812946
Station Location 4	812954
Station Location 3	824953
Station Location 2	838952
Station Location 1	851956
Sound Control Point	907006

All nine stations were to be manned from 1630 hours on 28 March, about 12 hours before the detonation, until after the shot when data collection had been completed (54; 57; 83).

3.1.3 Technical Service Projects

Three technical service projects were conducted to train personnel in the effects of nuclear detonations on vehicles and to train defense survey teams under radiological conditions.

Project 40.19, Sixth Army CBR Defense Team Training, was designed to evaluate the capabilities of Chemical, Biological, and Radiological (CBR) defense survey teams under radiological conditions. The project also tested equipment provided by the Army for these defense teams.

On 30 March, one day after the APPLE 1 detonation, two CBR defense teams, totaling 24 individuals, established a control point east of ground zero at the 0.1 R/h line. Five survey parties then established the 1.0 and the 5.0 R/h lines, approaching to within 100 meters of ground zero. This survey, which lasted 25 minutes, involved some communications delays and disabled jeeps. There is no record of any additional time spent in the radiation area because of these factors. Some incorrect

readings were taken and survey parties had to monitor the area again. The time required and the area remonitored are not known. The next day, the two CBR defense teams resurveyed the APPLE 1 area, establishing the 1.0, 5.0, and 10.0 R/h lines. They came within 55 meters of ground zero and also surveyed the area around the WASP PRIME ground zero (61).

Project 40.21, Ordnance Vehicular Equipment Tests, was conducted by Ballistic Research Laboratories. The objectives were to determine the effect of roll-over safety bars in minimizing damage to wheeled vehicles, to obtain experimental design data for the future development of ordnance equipment, and to investigate the shielding effect of armor against gamma radiation. The equipment was placed at various positions in the display area. The vehicles included M48 tanks, M59 armored personnel carriers, T97 self-propelled guns, 1/4-ton trucks, 2-1/2-ton cargo trucks, and 5-ton trucks.

The principal participant in the project was the 573rd Ordnance Company, which fielded the test equipment. Detroit Arsenal personnel also assisted in the fielding of the test vehicles. Ballistic Research Laboratories personnel from Military Effects Group Project 3.1, recorded blast pressures from gauges located near the test equipment, while Army personnel from the Chemical Warfare Laboratory conducting Project 2.7, took radiation measurements. After the detonation, Desert Rock VI troop observers inspected the vehicles. Dosimetry data were recovered from the vehicles when the Test Manager declared the area open for postshot recovery activities (102).

As part of the technical service program, Camp Desert Rock personnel assessed the damage to items in the equipment display area. This damage effects evaluation was not part of a numbered project.

3.2 DEPARTMENT OF DEFENSE PARTICIPATION IN MILITARY EFFECTS, SCIENTIFIC, OPERATIONAL TRAINING, AND SUPPORT ACTIVITIES AT SHOT APPLE 1

In addition to the Exercise Desert Rock activities described in the previous section, Department of Defense personnel performed a variety of tests during Shot APPLE 1 that required them to enter the forward area before, during, or after the shot. At 1118 hours, about one and one-half hours after the detonation, the Test Manager declared the area radiologically safe for recovery operations.

DOD personnel performed the 24 projects sponsored by the Field Command Military Effects Group and assisted in another four sponsored by the LASL test group, and four by the Civil Effects Tests Group. The Air Force, Navy, and Marine Corps also conducted six operational training projects. In addition, support activities accounted for a number of DOD participants at Shot APPLE 1. The Air Force Special Weapons Center (AFSWC) flew missions for the test groups and the Test Manager.

3.2.1 Department of Defense Participation in Military Effects Group Projects

The Military Effects Group conducted 24 projects at Shot APPLE 1, as shown in table 3-2. Table 3-2 lists the test group projects by numbers and title and identifies the fielding agencies and the estimated number of DOD participants. Because in most cases, many of the same project personnel performed both pre- and postshot activities, estimates reflect the maximum number of DOD participants who would have been involved in one aspect of the project. For example, if the project description states that 15 individuals performed preshot activities and five performed postshot recovery. the estimate listed in the table would be 15. The Test Manager allowed recovery operations to begin at 1118 hours. For several projects however, as indicated below, the Test Manger allowed participants to enter the area early.

Table 3-2: TEST GROUP PROJECTS WITH DEPARTMENT OF DEFENSE PARTICIPATION, SHOT APPLE 1

Project	Title	Participants	Estimated Personnel
	Military Effects Group		
1.1	Measurement of Free Air Atomic Blast Pressures	Air Force Cambridge Research Center	12
1.2	Shock Wave Photography	Naval Ordnance Laboratory	3
1.5	Preshock Sound Velocities Near the Ground in the Vicinity of an Atomic Explosion	Naval Electronics Laboratory	10
1.14b	Measurements of Air-blast Phenomena with Self-recording Gauges	Ballistic Research Laboratories	6
2.1	Gamma Exposure versus Distance	Army Signal Corps Engineering Laboratories	4
2.2	Neutron Flux Measurements	Naval Research Laboratory	5
2.6	Radiation Energy Absorbed by Human Phantoms in a Fission Fallout Field	Naval Medical Research Institute	10
2.7	Shielding Studies	Chemical Warfare Laboratory; Army Chemical Center	*
2.8a	Contact Radiation Hazard Associated with Contaminated Aircraft	Air Force Special Weapons Center	5
2.8b	Manned Penetration of Atomic Clouds	Air Force Special Weapons Center	4
3.1	Response of Drag-type Equipment Targets in the Precursor Zone	Ballistic Research Laboratories	28
5.1	Destructive Loads on Aircraft in Flight	Wright Air Development Center; Air Proving Ground	59
5.2	Effects on Fighter Type Aircraft in Flight	Wright Air Development Center	6
6.1.1a	Evaluation of Military Radiac Equipment	Army Signal Corps Engineering Laboratories	3
6.1.1b	Evaluation of a Radiological Defense Warning System	Army Signal Corps Engineering Laboratories	14
6.1.2	Accuracy of Military Radiacs	Naval Radiological Defense Laboratory	*
6.2	Effects on Selected Components and Systems	Army Signal Corps Engineering Laboratories	3
6.3	Missile Detonation Locator	Army Signal Corps Engineering Laboratories	*
6.4	Test of IBDA Equipment	Wright Air Development Center	40
6.5	Test of Airborne Naval Radars for IBDA	Bureau of Aeronautics	6
8.1	Measurement of Direct and Ground-reflected Thermal Radiation at Altitude	Bureau of Aeronautics	9

* Unknown

Table 3-2: TEST GROUP PROJECTS WITH DEPARTMENT OF DEFENSE PARTICIPATION, SHOT APPLE 1 (Continued)

Project	Title	Participants	Estimated Personnel
Military Effects Group			
8.4d	Spectrometer Measurements	Naval Radiological Defense Laboratory	*
9.1	Technical Photography	Lookout Mountain Laboratory; AFSWC; Air Force Missile Test Center; EG and G	9
9.4	Atomic Cloud Growth Study	Air Force Cambridge Research Center; Strategic Air Command; U.S. Weather Bureau; EG and G	*
Los Alamos Scientific Laboratory Test Group			
11.2	Radiochemistry Sampling	4926th Test Squadron (Sampling)	17
18.1	High Temperature Measurements	Naval Research Laboratory	*
18.3	Time Interval Measurements	Naval Research Laboratory	*
18.4	Spectroscopy	Naval Research Laboratory	*
Civil Effects Test Group			
33.1	Biological Effects of Pressure Phenomena Occurring Inside Protective Shelters Following a Nuclear Detonation	AEC, Division of Biology and Medicine; Lovelace Biomedical Research Laboratory	1
34.1b	Evaluation of Indoor Home Shelters Exposed to Nuclear Effects	Chemical Warfare Laboratory	*
34.3	Structural Behavior of Group Shelters Under Various Blast Loads	Chemical Warfare Laboratory	*
39.7	Physical Measurement of Neutron and Gamma Radiation Dose from High Neutron Yield Weapons and Correlation of Dose with Biological Effects	Air Force School of Aviation Medicine	1

* Unknown

Project 1.1, Measurement of Free Air Atomic Blast Pressures, used parachute-borne instrument canisters dropped from a B-29 aircraft to obtain data on the blast wave produced by the nuclear detonation. At 2400 hours on the day before the APPLE 1 test, two individuals traveled in one vehicle to a location 3.5 kilometers east of the shot-tower to complete servicing stations. Four hours before shot-time, 12 project personnel traveled in three vehicles to the Project 1.1 telemetering station located about 17 kilometers southeast of the shot-tower, at UTM coordinates 835892, to operate and record data through shot-time and until 45 minutes after the detonation. Because there is no record of radiological safety monitors having been assigned to this project on shot-day, it appears that recovery of the air-dropped instrument canisters was made some time after shot-day, when two individuals probably spent two hours retrieving equipment (51; 75; 77; 83).

Project 1.2, Shock Wave Photography, was conducted to evaluate the progression of the blast-wave produced by the nuclear detonation. Project personnel created a series of smoke trails in the air beyond the detonation to aid in photographic detection and measurement of blast wave effects.

At 2230 hours on the day before the test, three individuals traveled to a line located 1,040 meters due east of the shot-tower to load 16 rocket launchers with 16 live rounds. They then returned to Camp Mercury. Three hours before the shot, three individuals traveled in one vehicle to the Project 9.1 station in the Yucca Lake area. Their responsibility was to take a still photograph of the smoke rockets at shot-time to determine if all 16 rockets had fired. At shot-time, the 16 smoke rockets were fired to form a line pattern beyond the detonation.

One camera station with four cameras, which was probably unmanned, was located 4,100 meters west of the shot and outside

the 0.01 R/h zone. Two or three project personnel probably spent one hour, late on shot-day, recovering film from this station (75; 77; 83; 103).

Project 1.5, Preshock Sound Velocities near the Ground in the Vicinity of an Atomic Explosion, was designed to measure changes in the transmission of sound waves caused by changes in air pressure. Before the detonation, ten men probably worked five days to assemble the instrumentation at five stations in the shot area. At 2200 hours on the day before the shot, three men completed work at stations located about 825 and 1,500 meters north of ground zero.

The radiological safety report indicates that personnel from Project 1.5, accompanied by a radiological safety monitor, re-entered the area on shot-day to recover data and instruments. The recovery probably took three people two hours. Five men probably spent two days cleaning up the site (75; 77; 83; 100).

Project 1.14b, Measurements of Air-blast Phenomena with Self-recording Gauges, was fielded to measure air-pressure variations produced by a nuclear detonation. Self-recording pressure gauges and pressure-time instruments were placed on two lines extending from the shot-tower. One extended due north with one station located 820 meters from ground zero. The other line extended southwest with stations located at distances ranging from 310 to 1,800 meters from ground zero.

Preshot surveying, construction of instrumentation mounts, installation, and checking of gauges probably took six participants two weeks. After the shot, two men probably spent four hours recovering data at the most distant station. Recovery of the data from the remaining stations closer to ground zero was probably accomplished in two days by three individuals, when radiation intensities had decayed (75; 77; 83; 132).

Project 2.1, Gamma Exposure versus Distance, was designed to evaluate the gamma radiation exposure potential at various distances from a nuclear detonation. The project involved the location of film dosimeters, each loaded with two film packets, at 18 stations between 285 meters and 1,700 meters from the shot-tower. At 1218 hours, one hour after the Test Manager had declared that recovery operations could begin, three persons in a weapons carrier started collecting the film dosimeters located along the main access road. The recovery team began at the farthest station and worked toward ground zero as far as radiation levels permitted. One radiological safety monitor accompanied the recovery team, which spent an estimated 15 minutes conducting their activities (46; 75; 77; 83).

Project 2.2, Neutron Flux Measurements, was designed to evaluate neutron radiation at various distances from a nuclear detonation. Neutron detectors were arranged between 90 and 1,300 meters from the shot-tower. The neutron detectors closest to ground zero were attached to a long cable, while the remaining detectors were placed in canisters mounted on posts.

Since neutron detectors had to be analyzed as soon after exposure as possible, the Project 2.2 recovery team was permitted to follow the initial radiological survey team into the shot area at 0527 hours, about 32 minutes after the detonation. At that time, five individuals, including one radiological safety monitor, entered the area in one vehicle to pull in the detectors attached to the cables and to recover the canisters mounted on posts. It is estimated that these project personnel spent 30 minutes performing recovery activities (49; 75; 77; 83).

Project 2.6, Radiation Energy Absorbed by Human Phantoms in a Fission Fallout Field, involved measuring radiation intensities of fallout by placing masonite mannequins instrumented with radiation detectors at various stations within the fallout field after the detonation.

After recovery operations were initiated on shot-day, two teams, each consisting of four recovery personnel and one radiological safety monitor, entered the shot area in one vehicle and established two mannequin stations 2,340 meters due north of ground zero. At that point, the gamma radiation reading three feet above the ground was 1.6 R/h. This activity required an estimated ten minutes to complete. On the three days following the detonation, project personnel made three separate trips each day into the area to check instruments installed at the mannequin stations (65; 75; 77; 83; 97).

Project 2.7, Shielding Studies, was designed to evaluate the effectiveness of structures and equipment in reducing gamma and neutron radiation hazards. Before the shot, project personnel placed an M59 personnel carrier, a T97 self-propelled 155mm gun, and an M48 tank at various distances from the shot-tower. Project personnel placed gamma-radiation film badges on the equipment and recovered the film badges after the detonation when the Test Manager permitted re-entry into the shot area (29; 75; 77; 83; 133).

Project 2.8a, Contact Radiation Hazard Associated with Contaminated Aircraft, required approximately five individuals to survey the surface of the T-33 aircraft used in Project 2.8b, as well as the surfaces of some of the AFSWC cloud-sampling aircraft. Their objective was to determine how the degree of contamination varied as a function of time in the nuclear cloud. Each aircraft survey took approximately two hours. Because available documentation indicates that this project was conducted in the same manner at all shots at which it took place, the specific description of project procedures appears in the TEAPOT Series volume (13; 26; 35; 75; 77; 83).

Project 2.8b, Manned Penetrations of Atomic Clouds, required two T-33 aircraft from Indian Springs AFB to penetrate the

nuclear cloud at an altitude of 29,000 feet about 30 minutes after the detonation. Each aircraft was manned by a pilot and technical observer and spent about 16 seconds within the cloud. The aircraft then returned directly to Indian Springs AFB, landing about 15 minutes after takeoff (35; 75; 77; 83; 131).

Project 3.1, Response of Drag-type Equipment Targets in the Precursor Zone, was to determine the ability of vehicles to withstand the precursor-enhanced blast effects of a nuclear detonation. Six 1/4-ton trucks, three M48 tanks, an M59 armored personnel carrier, and a T97 self-propelled gun were positioned about 610 to 1,350 meters southwest of the shot-tower. In addition, four Desert Rock vehicles were placed in the same area to obtain further damage data.

At 2400 hours on the day before the detonation, three project personnel activated gauges at the vehicle and equipment stations. At 1718 hours, six hours after the Test Manager declared the area accessible for recovery operations, an estimated 23 personnel in five vehicles returned to the vehicle and equipment stations to perform recovery operations and to photograph the damage. Five monitors furnished by Project 1.3 and the Onsite Radiological Safety Support Unit accompanied the recovery team (9; 75; 77; 83).

Project 5.1, Destructive Loads on Aircraft in Flight, was designed to determine the structural responses and progression of damage to aircraft structures when subjected to the destructive blast forces produced by a nuclear detonation. Participation in this project at Shot APPLE 1 was in preparation for Shot MET, which was to test three QF-80K drone aircraft. Accurate positioning of these radio-controlled drone aircraft was essential to the success of the project. Therefore, the drones had been tested at Shot BEE on 22 March, with additional DT-33 aircraft controllers assisting in the effort. At APPLE 1,

however, no drone aircraft were flown, and Project 5.1 ground-controllers used their instruments for practice purposes only. No drone aircraft were launched at this shot.

Between 2300 and 2330 hours on 28 March, four project teams left Camp Mercury for MSQ-1 radar, telemetering, and communications control stations. They reached the stations about midnight and remained there until several hours after the detonation. A total of 59 personnel operated the four stations, located at distances of 24 to 27 kilometers south and southeast of the shot tower. The project personnel at these stations also monitored Project 5.2 aircraft in flight (35; 75; 77; 83; 111).

Project 5.2, Effects on Fighter Type Aircraft in Flight, was designed to evaluate the structural dynamics of the F-84F aircraft when exposed during flight to the effects of a nuclear detonation. The project involved both air and ground operations.

Two aircraft participated in the project. The first was in level-flight, oriented tail-on to the blast wave at a slant range of 4,410 meters and an altitude of about 13,330 feet above ground zero. The second aircraft was in level-flight, oriented side-on to the blast wave at a slant range of 8,090 meters and an altitude of about 6,470 feet above ground zero. Both aircraft returned to Indian Springs AFB following the maneuver.

The ground operations began at 2100 hours on 28 March, when two individuals in two vehicles left the main project station near the Control Point and proceeded north to another station located 17 kilometers northeast of the shot-tower. They checked project equipment installed in the station and then returned to the main project station near the Control Point, about five hours before the detonation.

At 1318 hours, 29 March, two hours after the Test Manager declared the shot area accessible, one participant proceeded to the station located 17 kilometers northeast of ground zero to turn off equipment. This trip to and from the area took an estimated two hours. A second participant proceeded to another station 25 kilometers southeast of ground zero to turn off equipment. Two radiological safety monitors accompanied these two personnel on their missions (35; 75; 77; 83; 112).

Project 6.1.1a, Evaluation of Military Radiac Equipment, evaluated radiation detecting instruments. Dosimeters in tubes were placed at 12 locations between 900 and 2,700 meters from the shot-tower. They were retrieved by three individuals, including a radiological safety monitor, approximately two hours after recovery operations were permitted by the Test Manager (15; 75; 77; 83).

Project 6.1.1b, Evaluation of a Radiological Defense Warning System (also known as Project CLOUDBURST), was conducted to evaluate components of a radiological defense warning system. The system was located about 16, 72, and 89 kilometers south of the shot-tower. Three project personnel spent about two days before the detonation selecting the site locations, mounting the detectors, and checking equipment. Postshot recovery of the detector systems was probably accomplished by three individuals in one day.

Project activities also involved an evaluation of dose-rate meters. Nine project personnel tested dose-rate meters in radiation fields for an estimated 30 minutes. Beginning their activities at 1218 hours, one hour after the Test Manager permitted recovery operations, the individuals spent no more than 15 minutes beyond the 5 R/h line and no time in the 10 R/h field. Five hours after recovery operations were initiated, two project participants placed radiac equipment in the residual radiation

field. The radiac equipment was recovered 24 hours later. Two radiological safety monitors accompanied project personnel in these activities (75; 77; 83; 107).

Project 6.1.2, Accuracy of Military Radiacs, was designed to measure the accuracy of standard military radiation-detection equipment and to measure the directional properties of gamma radiation emitted from fallout fields.

With the prior authorization of the Test Manager, personnel entered fallout areas as early as 0530 hours, 35 minutes after the detonation. These initial entries were followed by others at 1218, 1318, and 1618 hours. In the first entry, project personnel followed directly behind the initial radiological safety survey team, proceeding to an area of approximately 3 R/h, where they stopped to carry out readings on 25 instruments of five different types. Two other project personnel spent five minutes setting up a directional radiation detector and preparing the equipment for automatic scan.

At all times when crews were carrying out operations in radiation areas, extra vehicles were provided. Team operations were observed through field glasses, so that assistance could be provided in an emergency (75; 77; 83; 129).

Project 6.2, Effects on Selected Components and Systems, was conducted to evaluate the radiation effects of a nuclear detonation on the reliability of electronics equipment either in use or in storage at the time of a nuclear detonation. The components tested included electron tubes, crystal units, and radar beacons, both in operating and in storage conditions.

Before the detonation, an estimated three project personnel and two AEC contractor personnel worked two days placing the test

equipment at positions between 400 and 500 meters from the shot-tower. Recovery operations were accomplished in the days following the test event. Because the yield at this shot was lower than had been anticipated, the decision was made to conduct Project 6.2 again at Shot MET on 15 April (47; 75; 77; 83).

Project 6.3, Missile Detonation Locator, tested a radar system for possible use in determining the location of a nuclear detonation. The detonation locator consisted of broad-band receivers set up in California on baselines approximately 110 and 320 kilometers southwest of the NTS. Radio lines between the stations provided the time comparisons necessary to determine the relative times of arrival of the electromagentic pulse at each station (75; 77; 83; 101).

Project 6.4, Test of IBDA Equipment, was designed to gather engineering data for an Indirect Bomb Damage Assessment system installed in a B-50D aircraft. The maximum operating range of the yield-measuring component of the system received primary emphasis.

The B-50D IBDA system consisted of the standard radar set, AN/APQ-24; a bomb-damage evaluation group AN/APA-106 (XA-1); a recording set, light and time, AN/ASH-4 (XA-1); and a K-17 aerial camera. To determine the maximum operating range of the system, two F-94 aircraft, each probably manned by two crewmen, were instrumented with one ASH-4 recording set and one A-4 bomb-spotting camera. At this event, three B-50 aircraft were used while the two F-94s were positioned about 145 and 200 kilometers from ground zero at the time of detonation (28).

The B-50D, which staged out of Kirtland AFB, normally had a crew of ten. Since engineering evaluation tests were being conducted, one additional engineer and one technician accompanied the crew to monitor and ensure the operation of the IBDA system (28; 75;77; 83).

Project 6.5, Test of Airborne Naval Radars for IBDA, was conducted to test the suitability of unmodified operational Navy radars for Indirect Bomb Damage Assessment and to provide fleet personnel with experience in the analysis of IBDA data. Two AJ-2 aircraft with crews of three, flew at altitudes of 30,000 feet on an eastbound heading and were located 11 kilometers west of ground zero at the time of detonation. The aircraft continued on this course for about 30 seconds and then returned to San Diego (75; 77; 83; 130).

Project 8.1, Measurement of Direct and Ground-reflected Thermal Radiation at Altitude, was designed to study how the heat reflected from the earth surface contributed to the total heat received by aircraft in the vicinity of a nuclear detonation. At the time of detonation, an AD-4B aircraft was at a slant range of about 4,830 meters and an altitude of 11,190 feet above ground zero. An AD-5 aircraft was at a slant range of 4,940 meters and an altitude of 11,690 feet above ground zero. A third aircraft, an AD-6, was at a slant range of 6,225 meters and an altitude of 14,190 feet above ground zero. Following the detonation, these three aircraft returned directly to their staging base (75; 77; 83; 93).

Project 8.4d, Spectrometer Measurements, was designed to measure changes in the thermal radiation produced by a nuclear detonation. The recording instruments in Building 410 near the Control Point were not used during APPLE 1 because a higher priority for measurements was placed on WASP PRIME, detonated later in the day. A single ground station located 7.5 kilometers from ground zero was used to record thermal measurements (75; 77; 83; 109).

Project 9.1, Technical Photography, was designed to provide documentary photographs of the detonation. The project involved both a ground-photography mission and an air-photography mission.

Three hours before the shot, three individuals involved in the ground-photography mission traveled in one vehicle to a camera station 1.6 kilometers east of Yucca Lake at UTM coordinates 900890. They remained at the station until after shot-time, photographing the detonation. Meanwhile, an RC-47 aircraft with a crew of three and an estimated three cameramen, photographed the detonation at an altitude of 8,000 to 10,000 feet, 10 to 16 kilometers southeast of ground zero (33; 35; 75; 77; 83).

Project 9.4, Atomic Cloud Growth Study, was designed to study the development of the cloud produced by a nuclear detonation. Data on the rate of cloud rise and maximum cloud height were obtained from instruments located at the Control Point. Other data were obtained by the crews of two RB-47 aircraft, who photographed the detonation. At shot-time, one of the aircraft was at an altitude of 42,000 feet heading southeast at a horizontal range of 3.7 kilometers from ground zero. The second RB-47 flew at 43,000 feet, 25.8 kilometers from ground zero. Both aircraft, each of which were flown by three crewmen from the Strategic Air Command, returned to their home station, March AFB California, upon completion of their mission (35; 48; 75; 77; 83).

3.2.2 Department of Defense Participation in LASL and UCRL Test Group Projects

The Los Alamos Scientific Laboratory (LASL) conducted 23 projects at APPLE 1, but only four included DOD personnel, as shown in table 3-2.

Project 11.2, Radiochemistry Sampling, was performed by sampling pilots from AFSWC and is addressed in section 3.2.5 of this chapter.

Project 18.1, High Temperature Measurements, Project 18.3, Time Interval Measurements, and Project 18.4, Spectroscopy, were performed for LASL by the Naval Research Laboratory. Little is known about these projects, except that they involved photographing the APPLE 1 burst from unmanned camera stations located 19 kilometers from ground zero (14).

The University of California Radiation Laboratory (UCRL) Test Group conducted two projects at the APPLE 1 test event. However, there is no documentation of DOD participation in either project.

3.2.3 Department of Defense Participation in CETG Projects

The Civil Effects Test Group conducted several projects at APPLE 1, but only four involved DOD personnel, as shown in table 3-2.

Project 33.1, Biological Effects of Pressure Phenomena Occurring inside Protective Shelters Following a Nuclear Detonation, tested the effects of a nuclear blast on dogs, rats, and mice which were sealed in above- and below-ground instrumented shelters during the detonation. The data were used to check the biological effects of changes in pressures occurring in blast-protective shelters following nuclear detonations. The only recorded DOD participant in this project, which was conducted by the AEC Division of Biology and Medicine in conjunction with the Lovelace Medical Research Laboratory, was a single Air Force officer who assisted in a consultant capacity, but was not required to take part in fielding operations in the test area (20; 126).

Project 34.1b, Evaluation of Indoor Home Shelters Exposed to Nuclear Effects, and Project 34.3, Structural Behavior of Group Shelters under Various Blast Loads, evaluated the protection

against nuclear detonations provided by buried shelters. In these projects, DOD participants of the Army's Chemical Warfare Laboratory served as consultants, but did not take part in fielding operations in the shot area at the NTS (20; 75; 125).

Project 39.7, Physical Measurement of Neutron and Gamma Radiation Dose from High Neutron Yield Weapons and Correlation of Dose with Biological Effects, correlated radiation instrument measurements with biological effects in animals. Among the known project personnel was a DOD participant from the Air Force School of Aviation Medicine. Whether he worked in the field or served the project in a consultant capacity has not been documented (20; 50).

3.2.4 Department of Defense Operational Training Projects

Six operational training projects were conducted at Shot APPLE 1:

- Project 40.1, Evaluation of IBDA Equipments and Techniques
- Project 40.3, Crew Indoctrination
- Project 40.6, Calibration of Electromagnetic Effects
- Project 40.8, Calibration of Bomb Debris
- Project 40.10, Delivery Crew Indoctrination
- Project 40.13, Tactical Indoctrination for a Marine Aircrew.

Project 40.6 was a ground experiment, while the other five projects were air operations.

Project 40.1, Evaluation of Indirect Bomb Damage Assessment Equipment and Techniques, involved three Strategic Air Command RB-47 aircraft performing a training exercise of Indirect Bomb Damage Assessment techniques. At shot-time, these aircraft

simulated a horizontal delivery at 30,000 to 40,000 feet. Two minutes after the detonation, the aircraft left the area to return to March AFB, California (1; 3; 35; 105).

Project 40.3, Crew Indoctrination, involved 13 F-84s operating from George AFB, California. The project objective was to train Tactical Air Command aircrews in the effects of a nuclear detonation while flying simulated missions. The aircraft entered the shot area at 28,000 feet and were positioned by radar on an east-west pattern 32 kilometers northeast of ground zero. The aircraft descended to 18,000 feet, eight kilometers north of ground zero, then turned right and flew out of the shot area at the time of the detonation.

Ground personnel were scheduled to assist in this project. Two hours and 45 minutes before shot-time, ten individuals were scheduled to proceed to the MSQ-1 radar station located 44 kilometers from the APPLE 1 shot-tower at UTM coordinates 928626. They were to remain at the station through shot-time (1; 3; 35; 83; 105; 122).

Project 40.6, Calibration of Electromagnetic Effects, was performed by Air Force personnel who measured the characteristics of the electromagnetic pulse created by the detonation. Some personnel were required to occupy several permanent stations at various distances from ground zero during the detonation. On the day before the shot, three project personnel and a pilot traveled in a helicopter to station 40.6b on Yucca Lake to service recording equipment located ten to 20 kilometers from ground zero. These individuals left the area before sunset. At 0315 hours on shot-day, about 90 minutes before the detonation, five project personnel arrived at station 40.6b on Yucca Lake to operate equipment. They remained at their station until after the detonation, when the Test Manager permitted recovery operations to begin (3; 83; 106).

Project 40.8, Calibration of Bomb Debris, was also performed by Air Force personnel. This project analyzed airborne fission products and gases from the radioactive nuclear cloud. Collection of these samples was performed by the AFSWC 4926th Test Squadron (Sampling) aircraft at the same time that the aircraft collected nuclear cloud samples for LASL Project 11.2. This activity is discussed under AFSWC operations, in section 3.2.5 of this chapter (3; 35).

Project 40.10, Delivery Crew Indoctrination, involved eight AD aircraft and two AJ aircraft staging from San Diego, California. All aircraft were positioned by radar at altitudes of about 24,000 to 33,000 feet and locations about nine kilometers northeast of ground zero. These aircraft were abeam of ground zero 30 seconds before the detonation on a straight-in run. After the detonation, the aircraft made a righthand breakaway turn and returned to San Diego (1; 3; 35; 83; 105).

Project 40.13, Tactical Indoctrination for a Marine Aircrew, was performed by one AD aircraft, one R5D aircraft, and four F-9F aircraft staging out of the Marine Corps Auxiliary Air Station, California. These Marine Corps aircraft maintained a holding pattern 46 kilometers southwest of ground zero on an east-west orientation. The aircraft left the area about ten minutes after the detonation and returned to their staging base (1; 3; 35; 83; 105).

3.2.5 Air Force Special Weapons Center Activities

Air Force Special Weapons Center (AFSWC) support consisted of nuclear cloud-sampling missions, sample courier missions, cloud-tracking missions, and aerial surveys of terrain. Cloud sampling was conducted for LASL Project 11.2 and for Air Force Project 40.8.

Cloud Sampling

Shots APPLE 1 and WASP PRIME were detonated within five hours of each other on 29 March. The same cloud-sampling pilots flew missions at both shots, and the B-50 sampler control aircraft remained continuously airborne for the two tests.

At APPLE 1, six F-84G aircraft, each with a pilot, and one B-57A aircraft, with a pilot and an observer, collected particulate and gaseous samples of the nuclear cloud for LASL Project 11.2, Radiochemistry Sampling, and Air Force Project 40.8, Calibration of Bomb Debris. This was the first time a B-57A was involved as a sampling aircraft during a nuclear test. A B-50 aircraft, with a crew of nine, acted as the sampler control aircraft. The six F-84Gs and the B-57A collected samples at altitudes between 21,000 and 31,000 feet, with the first aircraft beginning sampling two hours after the detonation and the last aircraft beginning the mission four hours and 45 minutes after the detonation. The following listing presents information on the sampling mission of the seven aircraft (35):

AIRCRAFT	NUMBER OF PENETRATIONS	TOTAL TIME IN CLOUD (minutes: seconds)	HIGHEST INTENSITY (R/h)*
F-84G #028	2	2:00	32
F-84G #032	2	8:00	35
F-84G #051	2	1:40	2
F-84G #037	1	1:00	3
F-84G #038	4	7:00	10
F-84G #043	4	7:00	9
B-57A #424	2	18:00	3

*Roentgens per hour

Courier Service

Five aircraft left Indian Springs AFB to transport samples to various airbases for analysis by the laboratories of the projects involved. These courier missions were conducted by the 4900th Air Base Group from Kirtland AFB. Two C-119 aircraft left Indian Springs AFB at 1032 hours and 1035 hours for Kirtland AFB with samples for LASL. One C-119 aircraft left Indian Springs at 1050 hours for Oakland Municipal Airport and McClellan AFB, California, with a sample for Project 40.8, Calibration of Bomb Debris. A C-47 left Indian Springs at 1145 hours for Bolling AFB with samples for the Naval Research Laboratory. On 30 March, the day after APPLE 1, a C-45 aircraft left Indian Springs AFB at 1400 hours for Kirtland AFB with samples for LASL (35).

Cloud Tracking

Immediately after the APPLE 1 detonation, two aircraft, a B-50 from Kirtland AFB and a B-25 from Indian Springs AFB, flew cloud-tracking missions over and beyond the NTS. The B-50 flew at an altitude of 30,000 feet, while the B-25 flew at 12,000 feet. The aircraft followed the cloud for four hours and ten minutes due east as far as Kanab, Utah (35 - 37).

Aerial Surveys of Terrain

Aerial surveying was conducted after each TEAPOT event. After Shot APPLE 1, one C-47 aircraft operating from Indian Springs AFB conducted low-level surveying of the NTS and to the east offsite as far as Cedar City, Utah, at 300 to 500 feet. The aircraft and crew belonged to AFSWC, but the radiological safety monitor was a member of the 1st Radiological Safety Support Unit, working with the JTO. A second C-47 participated as a relay aircraft for Project 37. Since WASP PRIME was also conducted the same day, the terrain-survey flights for both shots were combined (35; 38).

3.3 RADIATION PROTECTION AT SHOT APPLE 1

The purpose of the various radiation protection procedures developed for Operation TEAPOT was to ensure that individual exposure to ionizing radiation was as low as possible, while allowing participants to accomplish the operational requirements of their missions. Some of the procedures described in the Series volume resulted in records which enabled Exercise Desert Rock, the Joint Test Organization, and AFSWC to evaluate the effectiveness of the procedures. Such records for APPLE 1, including film-badge data, have been located only for the Joint Test Organization. The JTO Onsite Radiological Safety Organization was staffed by the Army's 1st Radiological Safety Support Unit, from Ft. McClellan, Alabama, and was managed by AFSWP. The JTO information which will be presented in this section, includes film-badge data, logistical data on radiological safety equipment, survey results and records, isointensity plots, and decontamination records. Apparently, monitors from the 50th Chemical Service Platoon were present at Shot APPLE 1, as evidenced by the photograph in figure 3-3.

Because APPLE 1 and WASP PRIME were both detonated on 29 March, most of the information on dosimetry, logistics, and decontamination is common to both shots. This section presents that common information, as well as the data specific to APPLE 1.

Dosimetry Records

From 28 March to 4 April 1955, which covers the 29 March detonation of APPLE 1 and WASP PRIME, the Dosimetry and Records Section of the JTO issued 2,562 film badges and 590 pocket dosimeters. Film-badge readings indicate that through this period, 52 individuals had cumulative exposures between 2.0 and 3.9 roentgens. An additional ten individuals accumulated

Figure 3-3: RADIOLOGICAL SAFETY PERSONNEL OF THE 50TH CHEMICAL SERVICE PLATOON MEASURES THE RADIOACTIVITY OF A PIECE OF METAL FROM THE APPLE 1 TOWER

total exposures greater than 3.9 roentgens, the JTO-authorized exposure limit, and were excluded from entry into radiation areas for the remainder of Operation TEAPOT (19).

One individual from the USAF Test Unit who participated in CETG Project 39.7 recorded a film-badge reading of 1.15 roentgens on shot-day, making his total exposure 4.2 roentgens for the TEAPOT Series. One individual from the Naval Radiological Defense Laboratory received an exposure of 0.5 roentgens as a result of soil sampling activities conducted after Shots APPLE 1 and WASP PRIME, making his total for the series 4.1 roentgens. An individual from the 1st Radiological Safety Support Unit received a total gamma exposure of 4.45 roentgens by 29 March (17; 19).

Two personnel from the Chemical and Radiological Laboratory had cumulative gamma exposures of 4.1 and 4.2 roentgens after participating in APPLE 1 and possibly WASP PRIME. Three Air Force personnel, two from the 3083rd and one from the 3084th Aviation Depot Groups, received total gamma exposures of 5.07, 4.11 and 3.97 roentgens, respectively, up through shot day. Another individual from the Air Force, a member of Headquarters, 312th Fighter Bomber Group, had a cumulative gamma exposure of 4.4 roentgens after participating in APPLE 1 or WASP PRIME. An AFSWC pilot who conducted cloud sampling missions on 29 March received an exposure of 0.8 roentgens on shot day, making his total exposure 4.2 roentgens (17; 18; 19).

Logistical Data for Radiological Safety Equipment

For Shots APPLE 1 and WASP PRIME, the General Supply Section issued 1,936 pieces of protective clothing and 309 respirators. In addition, the Instrument Repair Section issued 378 radiacs (19).

Monitoring Activities

At Shot APPLE 1, the initial survey party, consisting of four or five two-man teams, road patrols, and checkpoint personnel, left the Control Point at 0500 hours, five minutes after the detonation, and began its survey of Area 4 at 0527 hours. The road patrol found that the area north on Mercury Highway from the Control Point to BJY and south on Mercury Highway to Frenchman Flat was free of radioactivity. Because the direction of fallout prevented the initial team from reaching stake line 1 to the northeast, it was necessary to complete the survey in this area using stake lines from Area 2. In addition, fallout caused the team assigned to stake line 8, which was due north, to approach from the west, rather than from the east as originally planned. The main check points were established by 0520 hours, and the initial survey was completed by 0640 hours. A copy of the initial isointensity map is shown in figure 3-4.

In addition to the ground survey, three H-19 aircraft, each with a crew of about five, performed an aerial radiological survey of the APPLE 1 ground zero area immediately after the detonation.

Resurveys of the area were made on 30 March and on 1, 12 and 20 April. Copies of the isointensity maps generated from the resurveys are shown in figure 3-5. The average exposures for the initial and first resurvey teams were 0.48 and 0.22 roentgens, respectively.

In addition to its survey work, the Monitoring Section provided monitors to a number of projects conducting recovery operations on shot-day. The assignment of these radiological safety monitors is summarized on the next page (19):

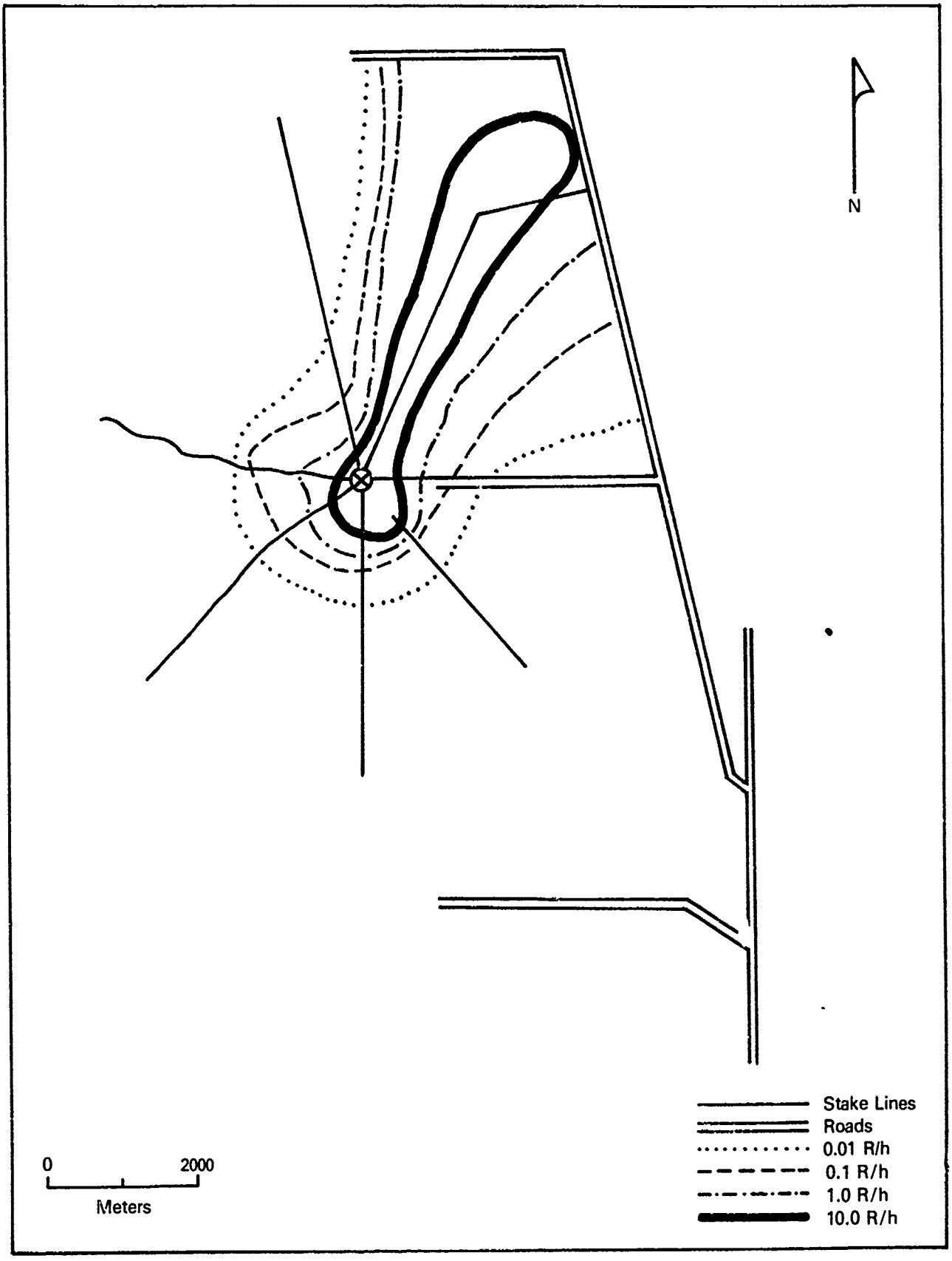
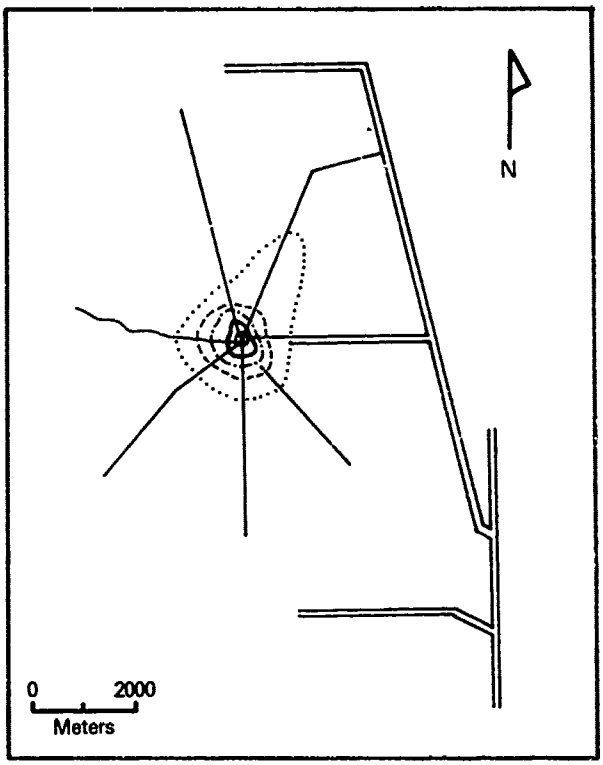
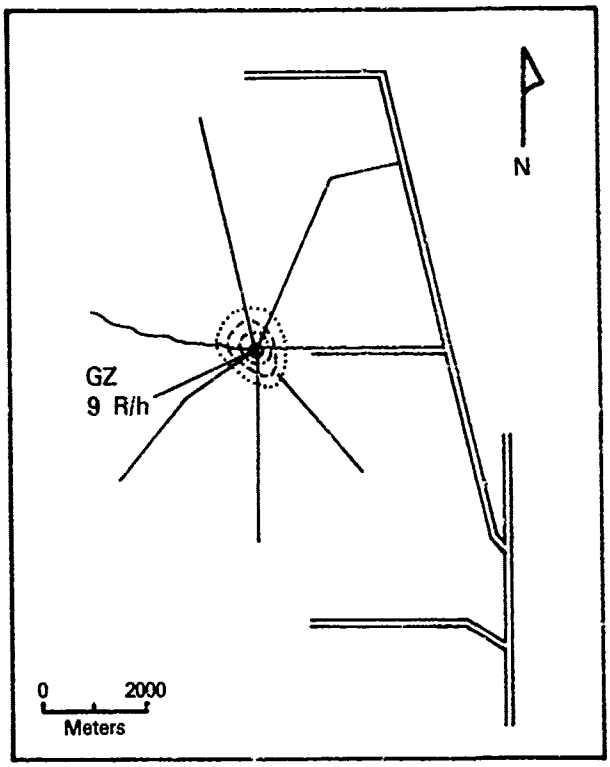


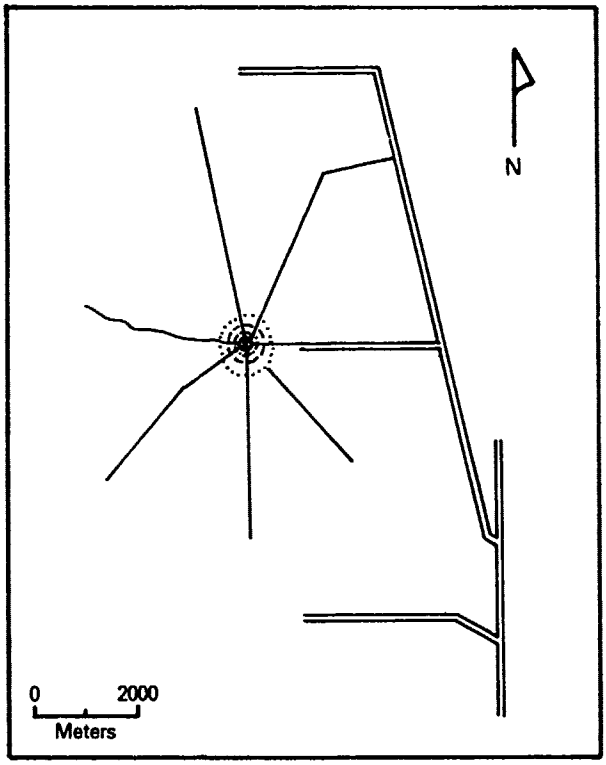
Figure 3-4: INITIAL SURVEY FOR SHOT APPLE 1, 29 MARCH 1955, 0527 TO 0640 HOURS



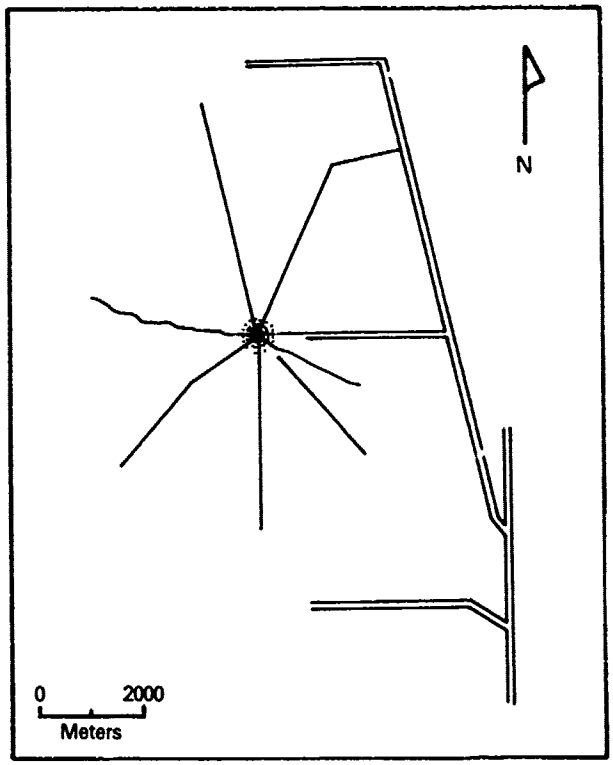
30 March 1955, 0645 to 0745 Hours



1 April 1955, 1122 to 1430 Hours



12 April 1955, 0830 to 0915 Hours



20 April 1955, 1500 to 1528 Hours

Stake Lines
Roads
0.01 R/h
0.1 R/h
1.0 R/h
10.0 R/h

Figure 3-5: RESURVEYS FOR SHOT APPLE 1

PROJECT	NUMBER
1.5	1
3.0	1
6.1.2	1
15.1	1
15.3	2
15.4	2
16	1
30.3	1
33	3
34.3	1
37.3	1
38.1	4
39.4	3
39.4a	1

The Monitoring Section also provided three monitors to the Reynolds Electrical and Engineering Company (REECo) and two monitors to Edgerton, Germeshausen, and Grier, Inc. (19).

Recovery and Re-entry Procedures

The Plotting and Briefing Section cleared 25 parties for entry into Area 4 on shot-day (19; 75).

The Test Manager announced a limited recovery hour for parties of Projects 2.2, 3.1, 6.1.2, 13.3, Program 18, and for parties of Edgerton, Germeshausen, and Grier and REECo. The announcement included the stipulation that they would clear the shot area by 0800 hours, two hours before the scheduled detonation of WASP PRIME. Normal recovery operations were resumed at 1118 hours, the declaration of recovery hour for both Shot APPLE 1 and Shot WASP PRIME (19).

Decontamination

During the period covering APPLE 1 and WASP PRIME, members of the Vehicle and Equipment Decontamination Section decontaminated 73 vehicles and seven trailers. Six of the trailers and one of the vehicles had been placed in the hot park to allow contamination to decay prior to decontamination. An additional

53 items of equipment were placed in the hot park. Most of the equipment decontaminated during this period had been used in the ESS shot area (19).

WASP PRIME

SHOT SYNOPSIS

AEC TEST SERIES:	TEAPOT
DOD EXERCISE:	Desert Rock VI
DATE/TIME:	29 March 1955, 1000 hours
YIELD:	3 kilotons
HEIGHT OF BURST:	737 feet (airdrop)

Purpose of Test: To test a new nuclear device for possible inclusion in the nuclear arsenal.

DOD Objective: (1) To study the effects of a nuclear weapon on military equipment
(2) To allow DOD personnel to observe a nuclear detonation.

Weather: At shot-time, the temperature at shot height was 12.4° C.; pressure at 845 millibars; surface winds up to shot height from the south-southwest at 16 knots, increasing to 25 knots from the southwest at 10,000 feet; 45 knots from the west-southwest at 20,000 feet; 63 knots from the west-southwest at 30,000 feet.

Radiation Data: Intensities around ground zero were the result of neutron-induced activity. Intensities greater than 0.1 R/h were confined to a relatively circular area extending about 2,500 meters out from ground zero.

Participants: Atomic Energy Commission, Exercise Desert Rock participants, Armed Forces Special Weapons Project, Air Force Special Weapons Center and other Air Force personnel, Los Alamos Scientific Laboratory, Federal Civil Defense Administration, contractors, DOD laboratories.

CHAPTER 4

SHOT WASP PRIME

Shot WASP PRIME, the ninth nuclear test of Operation TEAPOT, was detonated on 29 March 1955 at 1000 hours in Area 7 of the Nevada Test Site (NTS) at UTM coordinates 869047. The yield of the device was three kilotons (30). The firing of WASP PRIME five hours after the detonation of APPLE 1 marked the first time in the history of the nuclear test program that two nuclear devices were detonated on the same day.

A developmental device designed by the Los Alamos Scientific Laboratory (LASL), the WASP PRIME device was nearly identical to the WASP device detonated on 18 February 1955, the first test event of the TEAPOT Series. Like WASP, WASP PRIME was air-dropped from a B-36 aircraft. The B-36 entered the testing area at 0755 hours and completed six practice runs prior to the bombing run, which began at 0954 hours. At bomb release, the aircraft was on a heading of 260 degrees at 240 knots and at an altitude of 20,000 feet, where the winds were from the west at about 45 knots. The bomb was detonated at an altitude of approximately 740 feet above the surface of Yucca Flat (41; 70).

Department of Defense (DOD) participants at Shot WASP PRIME took part in Exercise Desert Rock activities, scientific and military effects experiments, and support missions, as described in this chapter. An account of the radiological situation created by Shot WASP PRIME, along with the procedures used to minimize the exposure of DOD participants to ionizing radiation, is summarized at the end of the chapter.

4.1 EXERCISE DESERT ROCK VI OPERATIONS AT SHOT WASP PRIME

Fewer than 100 Desert Rock exercise troops took part in one troop test and one technical service project at WASP PRIME. Table 4-1 displays Desert Rock VI activities at the shot.

Table 4-1: EXERCISE DESERT ROCK VI PROJECTS, SHOT WASP PRIME

Program Type	Project	Title	Estimated Personnel	Participants
Troop Test	40.18	Location of Atomic Bursts	49	Battery C (-), 532nd Field Artillery (Observation) Battalion
Technical Service	40.21	Ordnance Vehicular Equipment Test	*	Ballistic Research Laboratories; 573rd Ordnance Company; Detroit Arsenal; Chemical Warfare Laboratory

* Unknown

4.1.1 Troop Test

Project 40.18, Location of Atomic Bursts, was conducted by The Artillery School and employed 49 participants from Battery C (-), 532nd Field Artillery (Observation) Battalion. The objectives of the project were to test equipment and train troops in locating and determining the yield of a nuclear detonation. To perform the project, participants conducted field surveys using AN/TVS-1 cameras, MK-11 Bhangmeters, AN/MPQ-21X radar sets, and sound microphones. According to the Operation Order for WASP PRIME, personnel were to man nine survey stations. They were deployed to approximate an observation battery under tactical conditions. The locations of the stations are listed below (90):

STATIONS	UTM COORDINATES
Flash Control Point	794964
Station Location 1	834945
Station Location 2	824953
Station Location 3	810961
Station Location 4	794969
Station Location 5	775975
Station Location 6	754985
Sound Control Point	796984
Radar	800912

All nine stations were manned at 1600 hours on 28 March, 16 hours before the WASP PRIME detonation. After the shot and the completion of their data collection, project personnel returned to Camp Desert Rock (54; 90; 105).

4.1.2 Technical Service Projects

As listed in table 4-1, one technical service project was conducted to train personnel in monitoring radiation and in the effects of a nuclear detonation on military vehicles.

Project 40.21, Ordnance Vehicular Equipment Test, was conducted by the Ballistic Research Laboratories. The objectives were to determine the effect of roll-over safety bars in minimizing damage to wheeled vehicles, to obtain experimental design data for the future development of ordnance equipment, and to investigate the shielding effect of armor against gamma radiation. The equipment was placed in various positions in the display area. The vehicles included three M48 tanks, one M59 armored personnel carrier, one T97 self-propelled gun, six 1/4-ton trucks, six 2 1/2-ton cargo trucks, six cargo trucks, and four 5-ton trucks.

The principal participants in the project were from the 573rd Ordnance Company, which fielded the test equipment with the assistance of personnel from the Detroit Arsenal. Ballistic Research Laboratories personnel from the Armed Forces Special

Weapons Project (AFSWP) Military Effects Group Project 3.1 recorded blast pressures from gauges located near the Project 40.21 test equipment, while Chemical Warfare Laboratories personnel from Military Effects Group Project 2.7 took radiation measurements (54; 102).

4.2 DEPARTMENT OF DEFENSE PARTICIPATION IN MILITARY EFFECTS, SCIENTIFIC, OPERATIONAL TRAINING, AND SUPPORT ACTIVITIES AT SHOT WASP PRIME

In addition to the Exercise Desert Rock activities described in the previous section, Department of Defense personnel performed a variety of tasks during WASP PRIME that required them to enter the forward area before, during, or after the shot. The Test Manager declared the area safe for recovery operations at 1118 hours, one hour and 18 minutes after the detonation.

DOD personnel performed the 14 projects sponsored by the Field Command Military Effects Group and assisted in three sponsored by the LASL test group and one by the Civil Effects Test Group.

DOD personnel also performed three operational training projects and the Air Force Special Weapons Center (AFSWC) provided support to the test groups and to the Test Manager.

4.2.1 Department of Defense Participation in Military Effects Group Projects

The Military Effects Group of AFSWP Field Command conducted 14 projects at Shot WASP PRIME, as listed in table 4-2. Table 4-2 lists the test group projects by number and title, and identifies the fielding agencies and the numbers of DOD participants. Because in most cases many of the same personnel performed both pre- and postshot activities, estimates reflect the maximum number of DOD personnel who would have been involved

Table 4-2: TEST GROUP PROJECTS WITH DEPARTMENT OF DEFENSE PARTICIPATION SHOT WASP PRIME

Project	Title	Participants	Estimated Personnel
Military Effects Group			
1.2	Shock Wave Photography	Naval Ordnance Laboratory	2
2.1	Gamma Exposure versus Distance	Army Signal Engineering Laboratories	3
2.2	Neutron Flux Measurements	Naval Research Laboratory	7
2.4	Gamma Dose Rate versus Time and Distance	Evans Signal Laboratory; Army Chemical Center	*
2.8a	Contact Radiation Hazard Associated with Contaminated Aircraft	Air Force Special Weapons Center	5
3.1	Response of Drag-type Equipment Targets in the Precursor Zone	Ballistic Research Laboratories	6
6.3	Missile Detonation Locator	Army Signal Engineering Laboratories	4
6.4	Test of IBDA Equipment	Wright Air Development Center	16
8.4b	Thermal Measurements from Fixed Ground Installations	Naval Radiological Defense Laboratory	3
8.4c	Radiant Energy Delivered Prior to the First Minimum	Naval Radiological Defense Laboratory	*
8.4d	Spectrometer Measurements	Naval Radiological Defense Laboratory	*
8.4f	Bolometer Measurements	Naval Radiological Defense Laboratory	*
9.1	Technical Photography	Lookout Mountain Laboratory; AFSWC; Air Force Missile Test Center; EG and G	6
9.4	Atomic Cloud Growth Study	Air Force Cambridge Research Center; U.S. Weather Bureau; EG and G	*
Los Alamos Scientific Laboratory Test Group			
11.2	Radiochemistry Sampling	4926th Test Squadron (Sampling)	15
18.2	High Altitude Measurements	Naval Research Laboratory	*
18.4	Spectroscopy	Naval Research Laboratory	*
Civil Effects Test Group			
39.7	Physical Measurement of Neutron and Gamma Radiation Dose from High Neutron Yield Weapons and Correlation of Dose with Biological Effects	Air Force School of Aviation Medicine	1

* Unknown

in one aspect of the project. For example, if the project description states that 15 individuals performed preshot activities and five performed postshot recovery, the estimate listed in the table would be 15.

Project 1.2, Shock Wave Photography, was conducted to evaluate the progression of the blast wave produced by the nuclear detonation. Three cameras were operated at a station located approximately 3,100 meters from ground zero. The station, which was unmanned at shot-time, was just outside the 0.01 R/h line determined by the radiological safety surveys following the detonation. Two project personnel probably spent one hour recovering film from the camera station late on shot-day (82; 90; 103).

Project 2.1, Gamma Exposure versus Distance, was designed to evaluate the gamma radiation hazard at various distances from a nuclear detonation. The project involved the location of canisters with film packets in the predicted upwind sector of the shot area. Before the shot, personnel established 22 canister stations located from 250 meters to 1,660 meters from ground zero. At 1218 hours, approximately one hour after the Test Manager had declared that recovery operations could begin, two project personnel in a vehicle, with a team of Project 39.6 personnel, started recovering the dosimeters. The participants, who were accompanied by a radiological safety monitor from the Army Signal Engineer Laboratories, spent an estimated 15 minutes in recovery activities (46; 82; 90).

Project 2.2, Neutron Flux Measurements, was designed to evaluate the neutron radiation hazard at various distances from a nuclear detonation. Project personnel placed 15 canisters of neutron detectors at intervals within an area 180 to 720 meters south-southwest of ground zero. They also attached neutron detectors to a cable laid 90 to 720 meters south-southwest of ground zero.

Neutron detectors had to be analyzed as soon after exposure as possible. Therefore, the Test Manager allowed two recovery teams, each consisting of three individuals in one vehicle, to enter the test area to recover the neutron detectors and canisters behind the initial radiological survey team at 1033 hours, about 33 minutes after the detonation. One party pulled in the detector cable from its position 720 meters south-southwest of ground zero. The other party recovered canisters at locations 180, 360, 540, and 720 meters from ground zero. One radiological safety monitor accompanied the six project personnel in their postshot activities (49; 82; 90).

Project 2.4, Gamma Dose Rate versus Time and Distance, was performed to evaluate the gamma radiation hazard at various times after the detonation. The project involved the placement of three instrument stations at distances of 400, 410, and 590 meters from ground zero. The first station was located north-northwest, the second south-southwest, and the third southeast of ground zero. The instruments were recovered by project personnel after the detonation (45; 82; 90).

Project 2.8a, Contact Radiation Hazard Associated with Contaminated Aircraft, was designed to study the exposure potential presented by ground-crew contact with an aircraft that had flown through a nuclear cloud. Standard gamma-survey meters were held near the contaminated components of two AFSWC cloud-sampling aircraft to determine their radiation intensities. Several types of meters were used and their readings were compared. After the aircraft had landed, as many as five individuals took part in the survey, which took about two hours. Decay studies were conducted up to 24 hours after the detonation. Because available documentation indicates that this project was conducted in the same way at all shots at which it took place, the specific description of project procedures appears in the TEAPOT Series volume (26; 82; 90).

Project 3.1, Response of Drag-type Equipment Targets in the Precursor Zone, was to determine the ability of vehicles to withstand the precursor-enhanced blast effects of a nuclear detonation. Seven 1/4-ton trucks, which had sustained light damage during their use in Project 3.1 at Shot BEE, were positioned in the shot area. Three trucks were placed near the intended ground zero, and the four remaining trucks were placed along a line from about 100 to 300 meters southwest of the intended ground zero.

It is estimated that four individuals took one day each to place and instrument the vehicles before the detonation. After the shot, an estimated four personnel, including a crane operator, took one day to clear the area after radiation intensities were declared acceptable for recovery operations. In addition, two photographers probably spent a day each photographing the damage (9; 82; 90).

Project 6.3, Missile Detonation Locator, tested the feasibility of a tactical range detonation-locator system designed to detect and analyze the electromagnetic pulse emitted by the detonation. The detonation locator consisted of broad-band receivers set up in California on baselines approximately 110 and 320 kilometers southwest of the NTS. Radio links between the stations provided the time comparisons necessary to determine relative times of arrival of the electromagnetic pulse at each station.

According to the Operation Order for WASP PRIME, two project teams, each consisting of two individuals, were scheduled to arrive at two stations located on the NTS at UTM coordinates 830901 and 892868 the day before the test. These personnel were to operate the stations until one hour after the shot to obtain essential baseline data on the time of arrival of the electromagnetic pulse in the test area. After the project, they were to return to the Control Point (82; 90; 101).

Project 6.4, Test of IBDA Equipment, was designed to gather engineering evaluation data for a complete IBDA system installed in a B-50D aircraft and to determine the maximum operating range of the yield-measuring component of the system. The B-50D IBDA system consisted of the standard radar set, AN/APQ-24; a bomb-damage evaluation group, AN/APA-106 (XA-1); a recording set, light and time, AN/ASH-4 (XA-1); and a K-17 aerial camera. Two F-94 aircraft, each with one ASH-4 recording set and an A-4 bomb-spotting camera, were instrumented to determine the maximum operating range of the system.

The B-50D staged out of Kirtland AFB and normally had a crew of ten. Since engineer evaluation tests were being conducted, one additional engineer and one technician accompanied the crew to monitor and ensure the operation of the IBDA system. The F-94s were staged out of Indian Springs AFB, and probably had a crew of two. The B-50D was positioned by radar from three to seven nautical miles from ground zero, and simulated a weapons-delivery mission. The F-94s were positioned by the Air Operations Center at locations 35 to 153 nautical miles from ground zero. At least one crew member of each aircraft wore a film badge (28; 35; 82; 90).

Project 8.4b, Thermal Measurements from Fixed Ground Installations, was designed to measure and characterize the heat produced by a nuclear detonation at ranges where thermal radiation caused damage to military equipment. Thermal radiation was measured at stations 460 and 910 meters from ground zero. Preshot selection of sites and placement of instrumentation probably took two participants four hours. Postshot recovery of data was probably accomplished by two project personnel and a radiological safety monitor in one hour late on shot-day (62; 82; 90).

Project 8.4c, Thermal Measurements Prior to the First Minimum, studied characteristics of the thermal radiation produced by a nuclear detonation. Measurements of thermal radiation were made by high-sensitivity equipment installed in Building 410, located near the Control Point in Yucca Pass (63; 82; 90).

Project 8.4d, Spectrometer Measurements, was designed to measure changes in the thermal radiation produced by a nuclear detonation. As with Project 8.4c, the recording instruments were located in Building 410 near the Control Point Area (82; 90; 109).

Project 8.4f, Bolometer Measurements, measured changes in the amount of heat produced at various times after a nuclear detonation. All data were taken from Building 410, as they were for Projects 8.4c and 8.4d (67; 82; 90; 108).

Project 9.1, Technical Photography, was designed to provide documentary photographs of the detonation. For Shot WASP PRIME, Project 9.1 personnel performed ground photography for Project 1.2, Shock Wave Photography. During Shot WASP PRIME, only the air-photography mission was conducted. One RC-47 aircraft, which probably carried a flight crew of three persons and an estimated three photographers, was positioned between 10 and 16 kilometers southeast of ground zero at an altitude of 8,000 to 10,000 feet at shot-time. The RC-47, which returned to Indian Springs AFB after project personnel onboard had photographed the nuclear cloud, was manned by personnel from AFSWC and the Air Force Missile Test Center (33; 35; 82; 90).

Project 9.4, Atomic Cloud Growth Study, was designed to study the development of the cloud produced by a nuclear detonation. Data on the rate of cloud rise and maximum cloud height were obtained from instruments located at the Control Point (35; 82; 90).

4.2.2 Department of Defense Participation - LASL Test Group Projects

The Los Alamos Scientific Laboratory was the only AEC nuclear weapons development laboratory participating at Shot WASP PRIME. Along with developing the WASP PRIME nuclear device, the LASL Test Group conducted a number of projects at the shot, but only three included DOD participation. Table 4-2 lists DOD participation in these LASL projects.

Project 11.2, Radiochemistry Sampling, was performed by sampling pilots from AFSWC and is addressed in section 4.2.5 of this chapter.

Projects 18.2, High Altitude Measurements, and 18.4, Spectroscopy, were performed for LASL by the Naval Research Laboratory. Little is known about the activities associated with Program 18 in general or these two projects in particular (14).

4.2.3 Department of Defense Participation in CETG Projects

The Civil Effects Test Group conducted about seven projects at WASP PRIME. Of those seven projects, only one involved DOD personnel, as shown in table 4-2.

Project 39.7, Physical Measurement of Neutron and Gamma Radiation Dose from High Neutron Yield Weapons and Correlation of Dose with Biological Effects, correlated radiation instrument measurements with biological effects in animals. Among the known project personnel was a DOD participant from the Air Force School of Aviation Medicine.

According to the Test Director's schedule of events for WASP PRIME, Project 39.7 personnel were scheduled to complete placement of dosimeters and animals at stations located 90 to 1,100 meters east-northeast of ground zero by 2400 hours on the day before the shot.

Ten minutes after the shot, four recovery teams, each consisting of four FCDA project personnel and a radiological safety monitor, entered the shot area in one vehicle to recover equipment and animals. Available documents do not indicate the length of time spent by the recovery teams in the shot area, or whether the DOD participant served as a consultant or took part in the recovery effort (20; 50; 90).

4.2.4 Department of Defense Operational Training Projects

The Air Force conducted three operational training projects during Shot WASP PRIME:

- Project 40.3, Crew Indoctrination
- Project 40.6, Calibration of Electromagnetic Effects
- Project 40.8, Calibration of Bomb Debris.

Project 40.3, Crew Indoctrination, was intended to train Tactical Air Command aircrews in the effects of a nuclear detonation while flying simulated tactical delivery techniques and flyby maneuvers. Thirteen F-84 aircraft, staging from George AFB, California, conducted a flyby maneuver. These aircraft, each of which carried one pilot, performed their maneuver eight kilometers north of ground zero at altitudes of about 18,000 to 22,000 feet. At the time of the detonation, they broke away quickly to the north and then returned to George AFB.

The aircraft were positioned by MSQ-1 radar and other electronic devices located on the NTS and operated by project personnel before, during, and shortly after shot-time. Two hours before the detonation, ten airmen, six officers, and one civilian proceeded to the MSQ-1 radar station situated at UTM coordinates 930626, which was about 43 kilometers south of ground zero (1; 3; 35; 105; 106; 122).

Project 40.6, Calibration of Electromagnetic Effects, was performed by Air Force personnel, who measured the characteristics of the electromagnetic pulse created by the detonation. Part of the project required personnel to occupy several permanent stations at various distances from surface zero during the detonation. At 1300 hours on the day before the shot, two individuals flew in a helicopter to station 40.6b on Yucca Lake, 15 kilometers south of ground zero. They serviced eight sets of unmanned recording equipment at distances of 10 to 20 kilometers from surface zero. These individuals were in the shot area about four hours. At 0800 hours on shot-day, about two hours before the detonation, three individuals arrived at station 40.6b on Yucca Lake to operate equipment while two project personnel operated experimental equipment at station 40.6e on Angel's Peak. Participants remained at their stations until about 80 minutes after the detonation when the Test Manager permitted recovery operations to begin (3; 90; 106).

Project 40.8, Calibration of Bomb Debris, was also conducted by Air Force personnel. The project objective was to analyze airborne fission products and gases from the radioactive nuclear cloud. Collection of these samples was performed by AFSWC 4926th Test Squadron (Sampling) aircraft at the same time that the pilots collected cloud samples for LASL Project 11.2. This activity is discussed under AFSWC operations, in the following section (3; 35).

4.2.5 Air Force Special Weapons Center Activities

Air Force Special Weapons Center support consisted of nuclear cloud-sampling missions, sample courier flights, cloud-tracking missions, and an aerial survey of terrain.

Cloud Sampling

Six F-84G aircraft, each carrying a pilot, collected particulate and gaseous samples of the nuclear cloud for LASL Project 11.2, Radiochemistry Sampling, and Air Force Headquarters Project 40.8, Calibration of Bomb Debris. A B-50 aircraft, carrying a crew of ten, acted as the sampler control airplane. The F-84G aircraft collected samples at altitudes between 21,500 and 35,000 feet, with the first aircraft beginning cloud penetration one hour after the detonation and the final two aircraft entering the cloud two hours and 35 minutes after the detonation. The following listing presents information on the missions of the six sampling aircraft (35; 38):

AIRCRAFT	NUMBER OF PENETRATIONS	TOTAL TIME IN CLOUD minutes: seconds	HIGHEST INTENSITY (R/h)
F-84G #030	2	0:55	40
F-84G #033	1	6:25	20
F-84G #034	1	24:00	5
F-84G #046	1	24:00	6
F-84G #049	1	7:00	9
F-84G #053	1	7:00	8

Since APPLE 1 had been fired five hours before WASP PRIME, the B-50 sampler control plane remained airborne for both shots and the same sampler pilots flew both the APPLE 1 and WASP PRIME sampling missions. Because of a shortage of radiac instruments, it was necessary to decontaminate one of the sampler aircraft used at APPLE 1 and to transfer its radiac instruments to the aircraft used for WASP PRIME (35; 38).

Courier Service

After the sampling missions had been completed, four aircraft left Indian Springs AFB on shot-day to transport samples to various airbases for analysis by the project laboratories. These courier missions were conducted by the 4900th Air Base Group from Kirtland AFB. At 1300 hours on 29 March, a B-25 left Indian Springs AFB for Bolling AFB with samples for Naval Research Laboratory Project 2.2. At 1337 hours, a second B-25 left Indian Springs AFB for Kirtland AFB with samples for LASL. At 1350 hours, a third B-25 left Indian Springs AFB for Kirtland AFB with another load of cloud samples for LASL. At 1405 hours on 29 March, a C-47 left Indian Springs AFB for McClellan AFB with samples for Air Force Project 40.8 (35; 38).

Cloud Tracking

The B-25 cloud tracker used at APPLE 1 had also been scheduled for cloud tracking at WASP PRIME. Because the B-25 was contaminated while performing its mission at APPLE 1, a C-45 was readied for cloud tracking 18 minutes after the WASP PRIME detonation. This C-45, which carried the B-25 radiological safety monitor from the APPLE 1 event, experienced engine trouble and was forced to abort immediately after takeoff. Forty-five minutes after the WASP PRIME detonation, a second C-45 from the drone group attempted the cloud-tracking mission. This second C-45, however, was not able to find the cloud and, consequently, returned to Indian Springs AFB. All other cloud tracking at WASP PRIME was performed in conjunction with the APPLE 1 event and is discussed in the APPLE 1 chapter of this book, chapter 3, section 3.2.5 (35 - 38).

Aerial Surveys of Terrain

Because WASP PRIME and APPLE 1 were fired on the same day, the aerial survey flights for the two shots were combined. One

C-47 aircraft operating from Indian Springs AFB conducted low-altitude surveying of the NTS and the offsite area to the east at an altitude of 300 to 500 feet (35; 38).

4.3 RADIATION PROTECTION AT SHOT WASP PRIME

The purpose of the various radiation protection procedures developed for Operation TEAPOT was to ensure that individual exposure to ionizing radiation was as low as possible, while allowing participants to accomplish the operational requirements of their missions. Some of the procedures described in the Series volume resulted in such records as film-badge data which enabled Exercise Desert Rock, the Joint Test Organization (JTO), and AFSWC to evaluate the effectivenss of their procedures. Records for WASP PRIME have been located for the Joint Test Organization only. The JTO Onsite Radiological Safety Organization was staffed by the Army personnel of the 1st Radiological Safety Support Unit from Ft. McClellan, Alabama, and was managed by AFSWP. The JTO information which has been found includes film-badge data, logistical data on radiological safety equipment, survey results and records, copies of isointensity maps, and decontamination records. Other than the Final Dosage Report, no indication of Exercise Desert Rock VI or AFSWC radiological safety activities have been located.

Since WASP PRIME and APPLE 1 were detonated on the same day, 29 March, most of the information on dosimetry, logistics, and decontamination is not distinguished by shot, but relates to personnel and equipment associated with both tests. The information common to the two shots is given in chapter 3 of this volume, which discusses APPLE 1. For the most part, the data on monitoring and on plotting and briefing is separated by shot and is thus presented in the appropriate chapter.

Dosimetry Records

Dosimetry information for Shot WASP PRIME is the same as that for Shot APPLE 1 since both shots were detonated the same day. That information is presented in chapter 3, section 3.3, of this volume.

Logistical Data for Radiological Safety Equipment

The information on logistics is common to both Shots WASP PRIME and APPLE 1, and is given in the APPLE 1 chapter of this report, in section 3.3 of chapter 3.

Monitoring Activities

At WASP PRIME, the initial survey party, checkpoint teams, and road patrols left the Control Point at 1002 hours, two minutes after the detonation. Road patrols found the area on Mercury Highway from the Control Point south to Frenchman Flat and the area on Mercury Highway north to BJY clear of radioactivity. The initial survey teams began their survey of Area 7 at 1033. The survey was routine, and the teams were able to reach their stake lines on routes originally planned. The survey was completed by 1110 hours. A copy of the initial isointensity map is shown in figure 4-1. The helicopter survey began at 1020 hours and concluded at 1045 hours. Resurveys were conducted on 30 March and 2 April. Copies of the isointensity maps generated from the resurveys are shown in figure 4-2. The average exposures for the initial survey and first resurvey teams were 0.58 and 0.40 roentgens, respectively.

In addition to its survey work, the Monitoring Section provided monitors on shot-day and on the seven days after the detonation. The Monitoring Section met all requests for monitors, even though some monitors made two or three trips into the test area to meet project requirements.

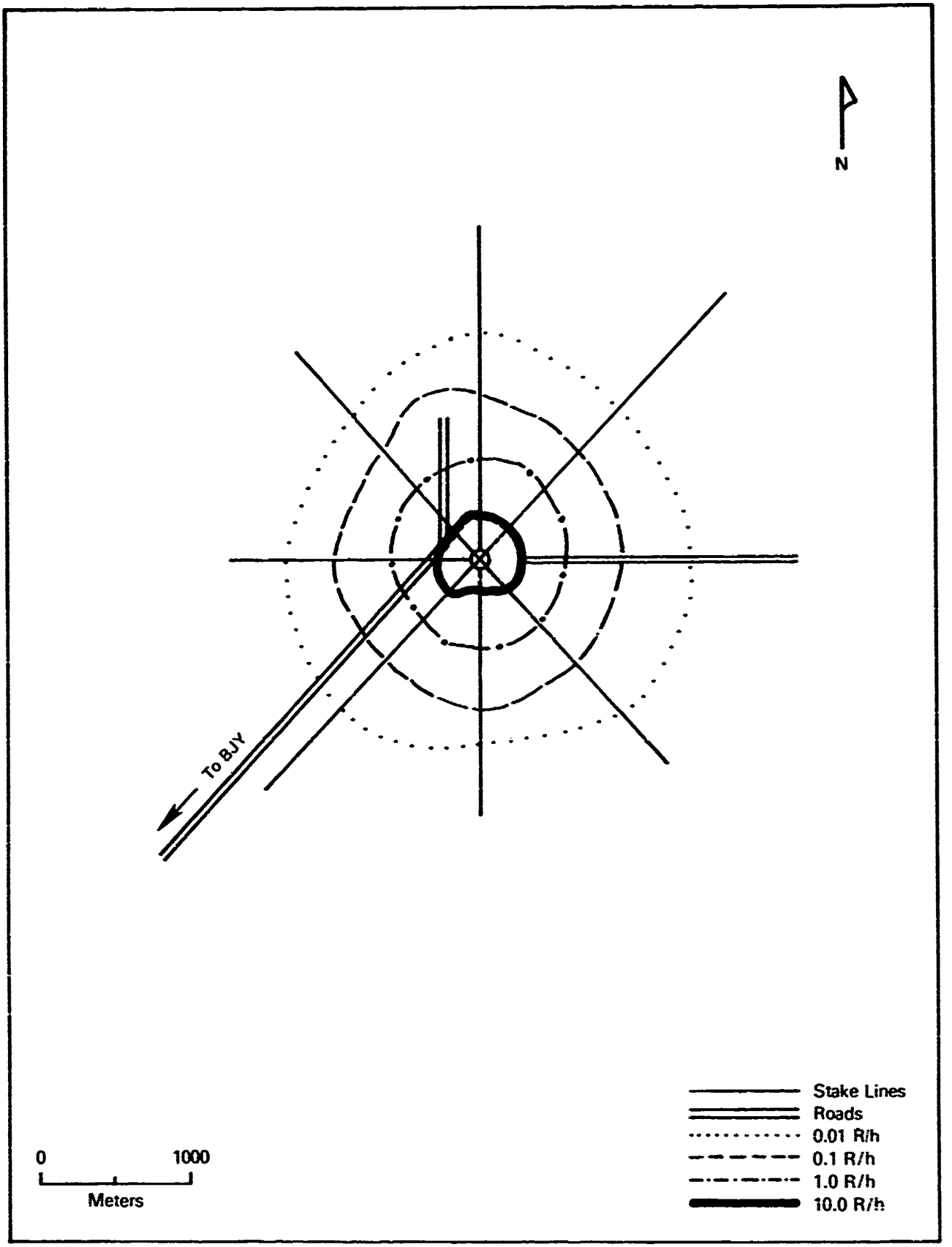
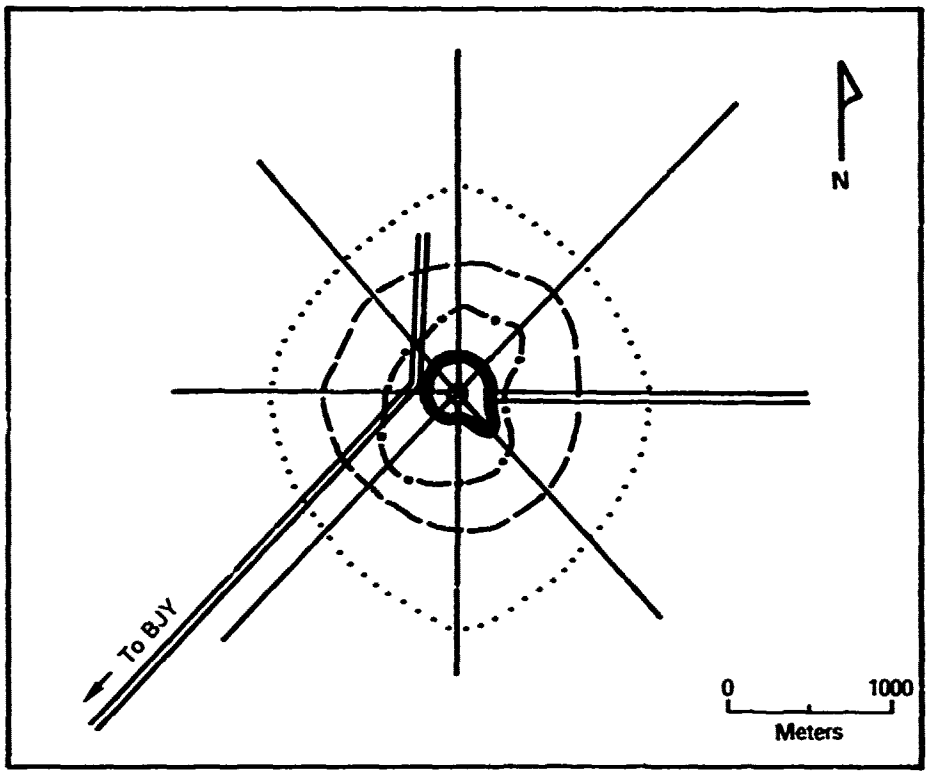
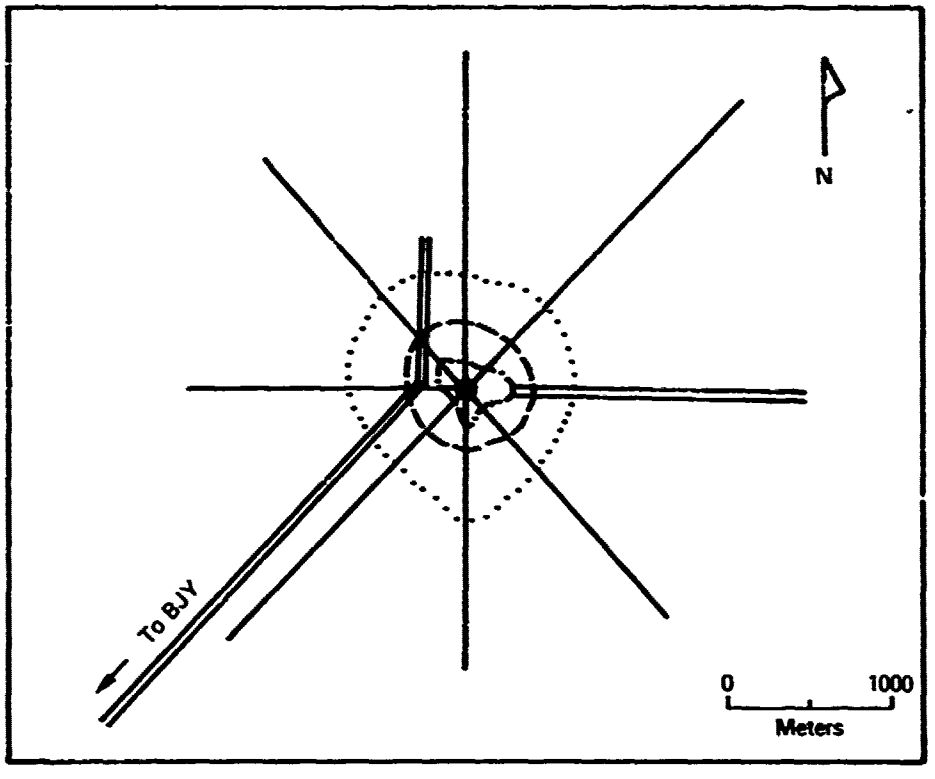


Figure 4-1: INITIAL SURVEY FOR SHOT WASP PRIME, 29 MARCH 1955, 1033 TO 1110 HOURS



30 March 1955, 0645 to 0728 Hours



1 April 1955

Stake Lines
Roads
0.01 R/h
0.10 R/h
1.00 R/h
10.00 R/h

Figure 4-2: RESURVEYS FOR SHOT WASP PRIME

On shot-day, monitors were provided to the following projects (19):

PROJECT	NUMBER
2.3	5
30.3	1
30.4a	1
39.7	4

On the days after the detonation, until 5 April, monitors were provided as follows (19):

PROJECT	NUMBER
1.1	1
1.9	1
2.2	1
2.3	5
2.5.1	2
2.5.2	1
2.7.1	5
3.1	7
6.1.1	1
8.4	1
13.1	1
15.4	1
33.4	2
34.3	4
39.4b	2
39.5	2
39.7	7
LASL J-12 Division	1

Recovery and Re-entry Procedures

The Test Manager declared recovery operations could begin for both APPLE 1 and WASP PRIME at 1118 hours. He authorized five Project 39.7 parties, and an unknown number of Oak Ridge National Laboratory personnel to enter areas with radiation intensities exceeding 10 R/h.

The Plotting and Briefing Section cleared 26 parties for entry into the WASP PRIME test area on shot-day and the following numbers

of parties for entry into the test area on subsequent days (19; 75):

DATE	NUMBER
30 March	73
31 March	25
1 April	21
2 April	13
3 April	3
4 April	12
5 April	5
6 April	5
7 April	4
8 April	6

Decontamination

The information on decontamination is common to both Shots APPLE 1 and WASP PRIME and is given in section 3.3 of chapter 3, which discusses radiation protection at APPLE 1 (19).

HA

SHOT SYNOPSIS

AEC TEST SERIES:	TEAPOT
DOD EXERCISES:	None
DATE/TIME:	6 April 1955, 1000 hours
YIELD:	3 kilotons
HEIGHT OF BURST:	36,620 feet MSL (airdrop)

Purpose of Test: To determine the military applications of a high-altitude nuclear detonation.

DOD Objectives: To study the phenomena associated with a high altitude nuclear detonation.

Weather: At shot-time, the temperature at shot height was -47.7° C; pressure at 222 millibars; winds were from the northwest at 27 knots at 30,000 feet, increasing to 28 knots from the west at 55,000 feet, at the top of the cloud.

Radiation Data: Because the device was detonated some 33,000 feet above Yucca Flat, there was no significant onsite fallout.

Participants: Atomic Energy Commission, Armed Forces Special Weapons Project, Air Force Special Weapons Center and other Air Force personnel, Los Alamos Scientific Laboratory, Federal Civil Defense Administration, contractors, DOD laboratories.

CHAPTER 5

SHOT HA

Shot HA, an abbreviation for High Altitude, the tenth nuclear test of the TEAPOT Series, was detonated on 6 April 1955 at 1000 hours. The HA test event was preceded by a non-nuclear dress rehearsal, Shot HADR, exploded on 25 March at 0900 hours. Shot HADR, an abbreviation for High Altitude Dry Run, was the eighth test of the TEAPOT Series and the only non-nuclear test conducted during Operation TEAPOT. The device used at HADR was a conventional high-explosive weapon designed by the Los Alamos Scientific Laboratory (LASL).

Shots HA and HADR were sponsored by the Department of Defense (DOD), whose tactical and strategic planners had long considered the military applications and effects of a high-altitude nuclear detonation. In October 1953, after studying the concept of using nuclear warheads for anti-aircraft rockets, the Armed Forces Special Weapons Project (AFSWP) recommended the scheduling of a high-altitude nuclear test to gather air defense information. AFSWP asked the Air Force Special Weapons Center (AFSWC) to study the feasibility of such a test. On 25 February 1955, Shot HADR was conducted to evaluate the final preparations for Shot HA, to be detonated on 6 April (42). The HA device, developed by LASL, was detonated at an altitude of 36,620 feet, with a yield of three kilotons (30). Because of the high altitude of the detonation, the typical mushroom-shaped cloud did not form. Instead, a high, billowy smoke ring developed which thinned out and disappeared in a very short time (41; 71; 72).

AFSWC instrumented a B-36 aircraft for the airdrop mission. For the effects of the HA test to be recorded, the aircraft was

fitted with canisters to be dropped with the device to record pressure and nuclear radiation data. In addition, thermal radiation measurement equipment was installed in the tail of the aircraft by the Naval Radiological Defense Laboratory, and two Project 8.4a personnel accompanied the AFSWC crew of 12 on the flight.

The HA airdrop was first planned for 4 March 1955, but mechanical difficulties delayed takeoff of the delivery aircraft and bad weather later in the day precluded maintaining the planned schedule. The test event was consequently rescheduled for 6 April 1955 (35; 41; 42; 53; 76).

A primary bombing altitude of 48,000 feet and an alternate altitude of 46,000 feet were established on 5 April. At 0800 hours on 6 April, the B-36 entered the shot area. While in the area, the B-36 experienced a power loss in one engine. Consequently, the alternate of 46,000 feet was established as the bombing altitude. The B-36 completed four practice runs before the delivery run, which began at 0954 hours. When the parachute-borne device was released at 46,000 feet, the aircraft was on a west-northwest heading over Area 1 of the NTS. When the device detonated at 36,620 feet, the B-36 was at a slant range of 6,300 meters from the point of detonation (35; 40 - 42; 52).

Eight other aircraft participated in the airdrop mission. Before release of the device, a B-47 with a crew of three, and seven F-86 smoke-trail aircraft each with one pilot, produced a smoke series of smoke trails. The smoke trails, which provided a means for measuring the effects of HA, were used for Military Effects Group Project 1.2. The smoke-laying aircraft passed below the B-36 delivery aircraft just prior to bomb release, moving out of range while the device fell (35; 41; 42).

No Exercise Desert Rock VI projects were conducted at HA. Department of Defense participants took part in the scientific and military effects projects, operational training projects, and support missions described in this chapter. An account of the radiological situation created by the HA detonation, along with the procedures used to minimize the exposure of DOD participants to ionizing radiation, is summarized at the end of this chapter.

5.1 DEPARTMENT OF DEFENSE PARTICIPATION IN MILITARY EFFECTS, SCIENTIFIC, OPERATIONAL TRAINING, AND SUPPORT ACTIVITIES AT SHOT HA

DOD personnel performed a variety of tasks during Shot HA that required them to enter the forward area before, during, and after the detonation. Because HA was a high-altitude shot and radiation was subsequently light, it was unnecessary to establish a definite recovery hour, as was done in other shots of this series. Seventeen of the projects in which DOD personnel took part were sponsored by the Military Effects Group, and two were conducted by the LASL test group. In addition, DOD personnel were active in four operational training projects, and various AFSWC support missions for the test groups and the Test Manager. Table 5-1 lists the Military Effects Group, LASL, and Civil Effects Test Group (CETG) projects by number and title, and identifies the fielding agencies and the estimated numbers of DOD participants involved.

5.1.1 Department of Defense Participation in Military Effects Group Projects

The Military Effects Group conducted 17 projects at Shot HA, as listed in table 5-1. Because in most cases, many of the same personnel performed both pre- and postshot activities, estimates reflect the maximum number of DOD personnel who would have been involved in one aspect of the project. For example, if the project description states that 15 individuals performed preshot

Table 5-1: TEST GROUP PROJECTS WITH DEPARTMENT OF DEFENSE PARTICIPATION, SHOT HA

Project	Title	Participants	Estimated Personnel
Military Effects Group			
1.1	Measurement of Free Air Atomic Blast Pressures	Air Force Cambridge Research Center	29
1.2	Shock Wave Photography	Naval Ordnance Laboratory	16
1.3	Microbarographic Pressure Measurements at Ground Level from High Altitude Shot	Sandia Laboratory	5
1.9	Material Velocity Measurements of a High Altitude Shot	Sandia Laboratory	*
2.1	Gamma Exposure versus Distance	Army Signal Engineering Laboratories	10
2.2	Neutron Flux Measurements	Naval Research Laboratory	10
2.8a	Contact Radiation Hazard Associated with Contaminated Aircraft	Air Force Special Weapons Center	5
5.1	Destructive Loads on Aircraft in Flight	Wright Air Development Center; Air Proving Ground	*
6.3	Missile Detonation Locator	Army Signal Engineering Laboratories	2
6.4	Test of IBDA Equipment	Wright Air Development Center	16
8.4a	Thermal Measurements from Aircraft in Flight	Naval Radiological Defense Laboratory	14
8.4b	Thermal Measurements from Fixed Ground Installations	Naval Radiological Defense Laboratory	3
8.4c	Thermal Measurements Prior to the First Minimum	Naval Radiological Defense Laboratory	*
8.4d	Spectrometer Measurements	Naval Radiological Defense Laboratory	*
8.4f	Bolometer Measurements	Naval Radiological Defense Laboratory	*
9.1	Technical Photography	Lookout Mountain Laboratory; AFSWC; Air Force Missile Test Center; EG and G	34
9.4	Atomic Cloud Growth Study	Air Force Cambridge Research Center; Army Map Service; U.S. Weather Bureau; EG and G	26
Los Alamos Scientific Laboratory Test Group			
11.2	Radiochemistry Sampling	4926th Test Squadron (Sampling)	17
18.2	High Altitude Measurements	Naval Research Laboratory	*

* Unknown

activities and five performed postshot recovery, the estimate listed in the table would be 15 (53; 76).

Project 1.1, Measurement of Free Air Atomic Blast Pressures, used parachute-borne instruments dropped from aircraft to obtain data on the blast wave produced in the atmosphere by nuclear detonations. For the high-altitude detonation, 15 parachute-borne canisters with crystal-controlled transmitters were released from the B-36 delivery aircraft seconds before the nuclear device was released. Canister recovery teams were briefed on shot-day concerning radiological safety procedures and entered the shot area to recover the canisters after the Test Manager declared that recovery operations could begin. It is estimated that two teams of six each spent two hours recovering the canisters.

Seventeen project personnel participated in Project 1.1. About four hours prior to shot-time, they proceeded to the Project 1.1 Telemetering Station, located nine kilometers south of surface zero, at UTM coordinates 835892, which was one kilometer west of News Nob. These project personnel operated the station and recorded data through shot-time and during the next 45 minutes, after which time they recovered their data and returned to the Control Point (51; 79; 84; 87; 98).

Project 1.2, Shock Wave Photography, was designed to produce a series of smoke trails to make blast waves from the detonation visible for photography. Eight aircraft, one B-47 and seven F-86s, created smoke trails above and beyond air zero from 70 seconds before the detonation and continued until 20 seconds before the device was dropped. Two ground camera stations, each with two cameras, were operated for this shot. The stations, the locations of which are not yet known, were probably each manned by three individuals. The camera personnel probably remained at the camera station for about one hour after the shot (79; 84; 87; 103).

Project 1.3, Microbarographic Pressure Measurements at Ground Level from High-altitude Shot, measured air pressure changes near the ground produced as a result of the high-altitude nuclear detonation. In order to obtain data from this experiment, personnel placed millibarographs and microbarographs before the shot at ground stations in a line from the intended ground zero south to Camp Mercury. Instrument distances ranged from about 3.6 kilometers south of ground zero to a spot near Camp Mercury, over 40 kilometers south of ground zero. In addition, Ballistic Research Laboratories provided self-recording pressure gauges placed at various distances north, southeast, and west of ground zero.

After the detonation on shot-day, five project personnel in two vehicles performed recovery operations, which included obtaining film records from self-recording pressure gauges at stations 360 meters and 720 meters south of ground zero and at a station 320 meters west of ground zero (79; 84; 87; 114).

Project 1.9, Material Velocity Measurements of a High-altitude Shot, was similar to Project 1.2, Shock Wave Photography, except that it was performed at a higher altitude. A number of smoke trails were produced in the air just before the detonation. A series of rapid time-lapse photographs were taken as the detonation occurred and its subsequent shock wave spread. These photographs were analyzed to show the displacement of the smoke particles in the air as they were affected by the shock wave from the high-altitude detonation (79; 84; 87; 113).

Project 2.1, Gamma Exposure versus Distance, was designed to evaluate the gamma radiation exposure potential at various distances from a nuclear detonation. National Bureau of Standards film dosimeters were placed in 15 steel canisters and released from the delivery aircraft at the same time the device was dropped. In addition, 12 ground dosimeter stations were

placed along a line 280 meters to 3,800 meters from surface zero. These canisters were probably recovered by ground crews from Project 2.2, who were assisted by two helicopters carrying Project 2.2 personnel. These helicopters located the canisters and directed ground crews to their locations. Two trucks, each with four personnel from Project 2.2, recovered the canisters. Two monitors furnished by Project 2.1 accompanied this recovery team. Recovery was probably accomplished shortly after the Test Manager declared recovery hour (46; 79; 84; 87).

Project 2.2, Neutron Flux Measurements, was designed to evaluate neutron radiation using Project 1.1 neutron detector canisters dropped from the delivery aircraft at the same time that it dropped the HA device.

Since neutron detectors had to be analyzed about 15 minutes after the HA detonation, two helicopters with AFSWC pilots and Project 2.2 personnel aboard set out to locate the Project 1.1 canisters and direct ground crew personnel to their locations. The recovery of these canisters and the ground detectors was performed by eight project personnel in two trucks. Two radiological safety monitors furnished by Project 2.1 accompanied the recovery team. One of the canisters was missing for several days, and the Test Director issued daily notices to all personnel to be alert for the missing canister (49; 79; 84; 87).

Project 2.8a, Contact Radiation Hazard Associated with Contaminated Aircraft, was to evaluate the radiation exposure potential to ground crews working on aircraft that had flown through a nuclear cloud. Radiation rates indicated by standard gamma survey meters held near the contaminated components of the aircraft were compared. As many as five personnel monitored the B-36 delivery aircraft and probably two of the AFSWC cloud-sampling aircraft used at the event. The monitoring, which began immediately after the aircraft returned to Indian Springs AFB,

took about two hours. The general procedures used in conducting the project are discussed in the TEAPOT Series volume (26; 79; 84; 87).

Project 5.1, Destructive Loads on Aircraft in Flight, was designed to assess how the overall structure of jet-fighter aircraft responded to the destructive blast forces produced by a nuclear explosion. It was supervised by personnel from the Wright Air Development Center, and the Air Proving Ground maintained and operated the aircraft participating in the project. Drone aircraft were tested at HA. In addition, project personnel operated M59-1 Radar, telemetering, and communications control stations to track the HA delivery aircraft on its bombing run. Personnel left the stations after the detonation and returned to Camp Mercury (79; 84; 87; 111).

Project 6.3, Missile Detonation Locator, was fielded to evaluate a tactical radar system used to determine the location of a nuclear detonation from the characteristic electromagnetic pulse emitted. The detonation locator consisted of broad-band receivers set up on baselines approximately 110 and 320 kilometers southwest of the NTS, in California. Radio links between the stations provided the time comparisons necessary to determine relative time-of-arrival of the electromagnetic pulse at each station.

The only onsite station for this project was located at UTM coordinates 918622, which was about four kilometers north of Camp Mercury. Two men operated the station from one hour before to one hour after the detonation, obtaining essential baseline data on the time-of-arrival of the electromagnetic pulse in the shot area (79; 84; 87; 101).

Project 6.4, Test of IBDA Equipment, was designed to gather engineering evaluation data for a complete IBDA system installed

in a B-50D aircraft. The second objective was to determine the maximum operating range of the yield-measuring component of the system.

The B-50D IBDA system consisted of the standard radar set, AN/APQ-24; a bomb-damage evaluation group, AN/APA-106 (XA-1); a light and time recording set, AN/ASH-4 (XA-1); and a K-17 aerial camera. To accomplish the second objective, two F-94 aircraft were each instrumented with one ASH-4 recording set and one A-4 bomb-spotting camera.

The B-50D staged out of Kirtland AFB and normally had a crew of ten. Since engineering evaluation tests were being conducted, one additional engineer and one technician went along to monitor and ensure the operation of the IBDA system. The F-94s, each with two crewmen, staged out of Indian Springs AFB. The B-50D, which was positioned by radar navigation, simulated an aircraft delivering a nuclear bomb. At shot-time, the B-50D was located from four to 11 kilometers from ground zero. The F-94s were positioned by the Air Operations Center between 110 and 160 kilometers from ground zero. At least one crew member of each aircraft wore a film badge (28; 35; 79; 84; 87).

Project 8.4a, Thermal Measurements from Aircraft in Flight, measured the thermal radiation produced by a high-altitude nuclear detonation. Radiant energy measurements were taken from the delivery aircraft employing MK7F calorimeters, Minneapolis-Honeywell thermopiles, and thin-foil calorimeters. The delivery aircraft probably carried two project personnel in addition to the flight crew of 12 AFSWC personnel (27; 79; 84; 87).

Project 8.4b, Thermal Measurements from Fixed Ground Installations, was designed to measure the thermal radiation from TEAPOT nuclear detonations. Standard thermal radiation measurements were made from ground installations located about 610 and 10,500 meters from surface zero.

Preshot selection of the sites and placement of the instruments probably took two individuals four hours. Postshot recovery of data was probably accomplished by two project personnel and a radiological safety monitor in one hour on shot-day, after the Test Manager declared the shot area open for recovery operations (62; 79; 84; 87).

Project 8.4c, Thermal Measurements Prior to the First Minimum, was designed to study characteristics of the thermal radiation produced by a nuclear detonation. Measurements of thermal energy were made by high-sensitivity equipment installed in Building 410, near the Control Point area in Yucca Pass (63; 79; 84; 87).

Project 8.4d, Spectrometer Measurements, was designed to measure thermal radiation characteristics of nuclear detonations by measuring the spectral distribution of radiant energy as a function of time. As with Project 8.4c, the recording spectrometer used in this project was located in Building 410 near the Control Point area (79; 84; 87; 109).

Project 8.4f, Bolometer Measurements, measured changes in the amount of heat produced at various times after a nuclear detonation. As with Projects 8.4c and 8.4d, all data were taken from Building 410 (67; 79; 84; 87; 108).

Project 9.1, Technical Photography, which provided technical and documentary photographs and motion pictures of the detonation, involved both a ground-photography mission and an air-photography mission.

The high-altitude event was filmed from two ground stations, one located at Lookout Peak and the other at the Frenchman Flat observation area. Each station was operated by a team of five project personnel, who arrived at the station three hours before

shot-time. The length of time that the teams remained at the two stations is not precisely known. However, since the high-altitude detonation produced a cloud that rapidly dissipated, project personnel probably left the stations within 30 minutes after shot-time.

One B-50 aircraft, with an AFSWC crew of nine plus about three photographers, staged from Indian Springs AFB, and performed the air-photography mission. Following the mission, the B-50 aircraft returned to Indian Springs AFB (33; 35; 79; 84; 87).

Project 9.4, Atomic Cloud Growth Study, was designed to study the development of the cloud produced by the nuclear detonation. Army Map Service personnel set up three camera stations for this project located 10 kilometers southeast, 11.6 kilometers southwest, and 12 kilometers southwest of the HA surface zero. Two project personnel went to the first station (10 kilometers southeast of the shot) three hours before the detonation and returned to the Control Point one hour before the detonation. Only one station was manned during the shot. It was probably the station 11.6 kilometers southwest of the shot, which was 1.6 kilometers west of the Control Point. Data on the rate of cloud rise and maximum cloud height were obtained from instruments located at the Control Point (35; 48; 79; 84; 87).

5.1.2 Department of Defense Participation in LASL Test Group Projects

The Los Alamos Scientific Laboratory was the only AEC nuclear weapons design laboratory active at Shot HA. The LASL Test Group conducted ten projects at this shot. Only Project 11.2, Radiochemistry Sampling, and Project 18.2, High Altitude Measurements, had DOD personnel involvement, as indicated in table 5-1.

Project 11.2, Radiochemistry Sampling, was performed by sampling pilots from the AFSWC 4926th Test Squadron (Sampling) and is discussed under AFSWC participation in section 5.1.5 of this chapter.

Project 18.2, High Altitude Measurements, was performed for LASL by the Naval Research Laboratory. Little is known about the activities associated with Program 18 in general, or Project 18.2 in particular.

5.1.3 Department of Defense Participation in CETG Projects

The Civil Effects Test Group conducted two projects at Shot HA. While available documents indicate DOD involvement in fielding operations at some shots, they do not specify such participation at Shot HA (22).

5.1.4 Department of Defense Operational Training Projects

Air Force personnel conducted four operational training projects at Shot HA:

- Project 40.2, Crew Indoctrination
- Project 40.6, Calibration of Electromagnetic Effects
- Project 40.8, Calibration of Bomb Debris
- Project 40.23, Crew Indoctrination.

Projects 40.2, 40.8, and 40.23 were air operational activities, while Project 40.6 was a ground operational training project.

Project 40.2, Crew Indoctrination, was to enable Strategic Air Command aircrews to observe a nuclear detonation while flying at medium altitudes in the immediate vicinity of the shot area. One KC-97 aircraft flew in a holding pattern about ten miles

south of air zero. After the crew of the KC-97 witnessed the detonation of HA, the aircraft returned to its staging area, Nellis AFB (3; 35).

Project 40.6, Calibration of Electromagnetic Effects, was performed by Air Force personnel, who measured the characteristics of the electromagnetic pulse created by the detonation. Part of the project required personnel to occupy several permanent stations located at various distances from ground zero during the detonation. At 0900 hours on the day before the shot, three individuals flew in a helicopter to station 40.6b on Yucca Lake, 9.6 kilometers south of surface zero, to service eight sets of unmanned recording equipment originally located ten and 20 kilometers from surface zero. The three personnel relocated the equipment one kilometer from ground zero. These participants were in the shot area about six hours.

About two hours before the scheduled detonation, three other project personnel arrived at station 40.6b, to operate equipment until two hours after the detonation. About the same time, another party of two individuals arrived at station 40.6e at Angel's Peak in the Spring Mountain Range to operate equipment until one hour after the detonation (84; 87; 105; 106).

Project 40.8, Calibration of Bomb Debris, was performed by the Air Force. The project objective was to analyze airborne fission products and gases from the radioactive nuclear cloud. Collection of these samples was performed by AFSWC 4926th Test Squadron (Sampling) aircraft and two Strategic Air Command (SAC) aircraft at the same time that the pilots collected cloud samples for LASL Project 11.2. This activity is discussed under AFSWC operations, in section 5.1.5 of this chapter (3; 35; 105).

Project 40.23, Crew Indoctrination, familiarized Air Defense Command aircrews with the effects of a nuclear detonation. Nine

T-33 aircraft, each with a crew of two and staging from George AFB, participated in this project. The aircraft flew in a northeast to southwest holding pattern about 25 kilometers southeast of air zero for about 15 minutes. Shortly after observing the detonation, the Air Defense Command personnel flew back to George AFB (3; 35; 84; 87; 105).

5.1.5 Air Force Special Weapons Center Activities

Air Force Special Weapons Center support at Shot HA consisted of nuclear cloud-sampling missions, sample courier missions, cloud-tracking missions, and aerial surveys of terrain. Cloud sampling was conducted for LASL Project 11.2 and for Air Force Project 40.8. The listing on the next page identifies the AFSWC missions flown at Shot HA and lists the types and numbers of aircraft and the estimated numbers of DOD personnel participating in the activities (35).

PROGRAM/ PROJECT	MISSION	TYPE OF AIRCRAFT	NUMBER OF AIRCRAFT	DOD PERSONNEL
	Prop Aircraft	B-36	1	12
11.2/40.8	Cloud Sampling			
	Sample Control	B-50	1	9
	Sampler	F-84G	4	4
	Sampler	B-57A	2	4
	Sampler	B-36	2	24
	Courier Service	C-119	3	12
		B-25	1	5
	Cloud Tracking	F-84G	2	2
		C-47	1	3
	Aerial Surveys of Terrain	H-19	2	10

Cloud Sampling

Nine aircraft were scheduled to collect particulate samples of the nuclear cloud for LASL Project 11.2, Radiochemistry

Sampling, and Air Force Project 40.8, Calibration of Bomb Debris. The six sampler aircraft flown by pilots of the 4926th Test Squadron (Sampling) included four F-84Gs and two B-57As. Two B-36 aircraft, flown by Strategic Air Command aircrews, were also scheduled to perform sampling missions: three of the four F-84Gs and one of the B-36s were unable to collect particulate samples because of the height of the nuclear cloud. The sampler pilots reported that the HA cloud dissipated rapidly and was difficult to see. The aircraft that did succeed in their missions collected samples at altitudes ranging from 44,000 to 53,000 feet. The first sampler began collecting 36 minutes after the detonation, and the final aircraft began 50 minutes after shot-time. The listing on the next page presents information on the sampling missions conducted by two of the F-84G aircraft, two B-57As, and one B-36 aircraft (35; 38).

AIRCRAFT	NUMBER OF PENETRATIONS	TOTAL TIME IN CLOUD (minutes: seconds)	HIGHEST INTENSITY (R/h)
F-84G #043	2	1:30	10
F-84G #055	2	1:00	15
B-57A #419	1	2:00	100
B-57A #424	1	3:00	50
B-36 #5721	2	5:30	0.6

Cloud Tracking

A new technique of tracking fallout was performed at Shot HA. Two F-84G aircraft and a support C-47 aircraft conducted long-range tracking of fallout from HA eastward across the U.S. The aircraft, staging from Andrews AFB, first followed the fallout on a course to Knoxville, Tennessee; Evansville, Indiana; Dyersburg, Tennessee; and Nashville, Tennessee; landing at Sewart

AFB, Tennessee for refueling. The aircraft then tracked the fallout from Nashville to Columbia, South Carolina; Raleigh, North Carolina; and Norfolk, Virginia to Andrews AFB, Maryland. The last mission was flown form Andrews to Myrtle Beach AFB, South Carolina, and back. All pilots from the tracking missions phoned information gained during their flights to the Operations Center at Air Force Headquarters. The information was used to plot the fallout path (35 38).

Courier Service

The 4900th Air Base Group conducted several courier missions on shot-day. In all, four aircraft transported samples to various airbases for delivery to agencies and projects throughout the U.S. A C-119 aircraft left Indian Springs AFB at 1303 hours for Kirtland AFB with samples for LASL. A C-119 departed from Indian Springs AFB at 1307 hours for Kirtland AFB also with samples for LASL. At 1312 hours, a C-119 flew from Indian Springs AFB for McClellan AFB with a load of samples for Air Force Headquarters Project 40.8. The last aircraft to leave Indian Springs AFB with samples was a B-25, which left at 1757 hours on shot-day for the Naval Research Laboratory (35; 38).

Aerial Surveys of Terrain

Since the HA device was detonated at 36,620 feet mean sea level, there were no earth or tower materials drawn into the cloud and, therefore, no significant onsite fallout was detected. Consequently, no low-altitude terrain surveys were performed following this shot. Two H-19 helicopters were, however, used to conduct a survey of an undisclosed area following the detonation (35; 38).

5.2 RADIATION PROTECTION AT SHOT HA

The purpose of the various radiation protection procedures developed for Operation TEAPOT was to ensure that individual

exposure to ionizing radiation was as low as possible, while allowing participants to accomplish their operational requirements. Because the HA device was detonated at 36,620 feet mean sea level, ground-based radiological safety support was minimal. These support activities were limited to dosimetry, monitoring, plotting and briefing, and decontamination.

Dosimetry Records

From 5 April to 7 April 1955, which covers the 6 April detonation of Shot HA, the Dosimetry and Records Section of the JTO issued 1,111 film badges and 172 pocket dosimeters (19).

Available film-badge readings indicate that during this time, ten persons accumulated exposures for the TEAPOT Series between 2.0 and 3.9 roentgens. Another individual accumulated an exposure greater than 3.9 roentgens during this period. This individual was a civilian who, before Shot HA, had worked with CETG Project 39.7. During Shot HA, he participated in Military Effects Group Project 2.2 and received an exposure of 0.7 roentgens. His total exposure became 4.3 roentgens and, therefore, he was not permitted to enter radiation areas during the remainder of the TEAPOT Series (17; 18).

Film-badge readings are available for seven AFSWC pilots who participated in activities at Shot HA. The six cloud-sampling pilots had film-badge readings that ranged from 0.1 to 0.8 roentgens of gamma radiation exposure. The pilot of the B-36 delivery aircraft had a film-badge reading of 0.8 roentgens (35).

Monitoring Activities

Shot HA was a high-altitude event with no significant onsite fallout occurring. As a result, ground surveys were unnecessary, and no protective clothing or radiation survey meters were issued. Two radiological safety monitors were provided to accompany Project 2.1 and 2.2 personnel, and one

provided to accompany Project 39.4a personnel in recovering the dosimetry canisters used in these projects (19; 75).

Recovery and Re-entry Procedures

The only briefings conducted for Shot HA were for the three parties recovering airdropped dosimetry canisters in the test site area (19).

Decontamination Activities

During the period covering Shot HA, 5 April to 7 April, members of the Vehicle and Equipment Decontamination Section placed 21 canisters and seven cargo-type parachutes containing instrumentation for Projects 2.1, 2.2, and 39.4 in the hot park after project personnel had removed the instruments from the equipment. In addition, members of the Vehicle and Equipment Decontamination Section decontaminated 18 vehicles which had been used in other test areas (19).

POST

SHOT SYNOPSIS

AEC TEST SERIES:	TEAPOT
DOD EXERCISE:	Desert Rock VI
DATE/TIME:	9 April 1955, 0430 hours
YIELD:	2 kilotons
HEIGHT OF BURST:	300 feet (tower shot)

Purpose of Test: To test a nuclear device for possible inclusion in the nuclear arsenal.

DOD Objectives: (1) To study the effects of a nuclear weapon on military equipment
(2) To allow DOD personnel to observe a nuclear detonation.

Weather: At shot-time, the temperature at shot-height was 4.5° C; 867 millibars; wind calm up to 13,000 feet, with winds 14,000 to 16,000 feet from the north-northwest at about 7 knots.

Radiation Data: During the initial survey, taken from 0455 to 0600 hours on shot-day, onsite fallout of 10.0 R/h was detected around ground zero, extending south. Onsite fallout greater than 0.01 R/h occurred south and east of ground zero and extended up to eight kilometers southwest of ground zero.

Participants: Atomic Energy Commission, Exercise Desert Rock participants, Armed Forces Special Weapons Project, Air Force Special Weapons Center and other Air Force personnel, Los Alamos Scientific Laboratory, University of California Radiation Laboratory, Federal Civil Defense Administration, contractors, DOD laboratories.

CHAPTER 6

SHOT POST

Shot POST, the eleventh nuclear test of the TEAPOT Series, was detonated on 9 April 1955 at 0430 hours in Area 9 of the Nevada Test Site (NTS), at UTM coordinates 860086. Detonated from a 300-foot tower, POST produced a nuclear yield of two kilotons (30). The device was sponsored, designed, and developed by the University of California Radiation Laboratory (UCRL).

The nuclear cloud top reached a height of 15,500 feet. Most of the fallout was scattered over the NTS and adjoining areas with fallout also spreading to the southeast, causing some concern that it would affect the Indian Springs Air Force Base (AFB) area and require the evacuation of personnel and aircraft; however, radiation levels proved to be low and evacuation was not necessary (41; 73).

Department of Defense (DOD) participants at Shot POST took part in Exercise Desert Rock activities, scientific and military effects experiments, and support missions, as described in this chapter. An account of the radiological situation created by Shot POST, along with the procedures used to minimize the exposure of DOD participants to ionizing radiation, is summarized at the end of the chapter.

6.1 EXERCISE DESERT ROCK VI OPERATIONS AT SHOT POST

Fewer than fifty Desert Rock exercise troops took part in the one troop test conducted at Shot POST.

Project 40.18, Location of Atomic Bursts, was conducted by Battery C (-) of the 532nd Field Artillery (Observation)

Battalion. The objectives of the project were to test equipment and train troops to locate and determine the yield of the nuclear detonation on a three-dimensional grid. The surveys were carried out with AN/TVS-1 cameras, MK-11 Bhangmeters, AN/MPQ-21X radar sets, and sound microphones. An estimated 46 project personnel manned nine survey stations approximating the positions of an observation battery under tactical conditions. The stations were at the following locations (86).

STATION	UTM COORDINATES
Flash Control Point	794964
Station Location 1	834945
Station Location 2	824953
Station Location 3	810961
Station Location 4	794968
Station Location 5	775976
Station Location 6	758985
Sound Control Point	796983
Radar	800912

Project personnel arrived at their positions at 1630 on 8 April and stayed through the detonation. The coordinates place the troops and equipment on a northwest to southeast line stretching from Area 1 north of the Control Point and west of Mercury Highway, an average distance of about 16 kilometers southwest of the shot-tower (54; 86; 105).

6.2 DEPARTMENT OF DEFENSE PARTICIPATION IN MILITARY EFFECTS, SCIENTIFIC, OPERATIONAL TRAINING, AND SUPPORT ACTIVITIES AT SHOT POST

The test groups and units of the Joint Test Organization (JTO) conducted 38 military effects, scientific, and operational training projects during the POST event. DOD personnel performed a number of tasks in the forward area before, during, and after the detonation. At 0615 hours, one hour and 45 minutes after the detonation, the Test Manager declared the area safe for recovery operations. The Military Effects Group conducted 13 projects and DOD personnel supported one scientific project sponsored by the

Los Alamos Scientific Laboratory (LASL) Test Group, one sponsored by the UCRL Test Group, and one sponsored by the Civil Effects Test Group (CETG). Table 6-1 lists the test group projects with DOD participation, including the fielding agency and the estimated numbers of DOD personnel. In addition, three operational training projects were conducted by the armed services. Air support was also provided to the JTO and the test groups by the Air Force Special Weapons Center (AFSWC).

6.2.1 Department of Defense Participation in Military Effects Group Projects

The Military Effects Group performed 13 projects at Shot POST, as listed in table 6-1. Because in most cases many of the same participants performed both pre- and postshot activities, estimates reflect the maximum number of DOD personnel who would have been involved in one aspect of the project. For example, if the project description states that 15 participants performed preshot activities and five performed postshot recovery, the estimate listed in the table would be 15.

Project 1.2, Shock Wave Photography, was fielded by the Naval Ordnance Laboratory. Two camera stations were used to photograph the development and progress of the shock wave produced by the nuclear detonation (81; 86; 103).

The objective of Project 1.14b, Measurements of Air-blast Phenomena with Self-recording Gauges, was to measure blast forces produced by a nuclear detonation. Instruments were placed on two blast lines, one extending south of the shot-tower with instruments at distances ranging from 200 to 670 meters, and the other extending southwest of the shot-tower with instruments at distances ranging from about 900 to 1,350 meters (132).

Table 6-1: TEST GROUP PROJECTS WITH DEPARTMENT OF DEFENSE PARTICIPATION, SHOT POST

Project	Title	Participants	Estimated Personnel
Military Effects Group			
1.2	Shock Wave Photography	Naval Ordnance Laboratory	*
1.14b	Measurements of Air-blast Phenomena with Self-recording Gauges	Ballistic Research Laboratories	6
2.1	Gamma Exposure versus Distance	Army Signal Engineering Laboratories	4
2.2	Neutron Flux Measurements	Naval Research Laboratory	6
2.3b	Gamma Radiation Fields Above Fallout Contaminated Ground	Naval Radiological Defense Laboratory	4
2.7	Shielding Studies	Chemical Warfare Laboratory; Army Chemical Center	7
2.8a	Contact Radiation Hazard Associated with Contaminated Aircraft	Air Force Special Weapons Center	5
3.1	Response of Drag-type Equipment Targets in the Precursor Zone	Ballistic Research Laboratories	*
6.3	Missile Detonation Locator	Army Signal Engineering Laboratories	*
6.4	Test of IBDA Equipment	Wright Air Development Center	16
8.4d	Spectrometer Measurements	Naval Radiological Defense Laboratory	*
8.4f	Bolometer Measurements	Naval Radiological Defense Laboratory	*
9.4	Atomic Cloud Growth Study	Air Force Cambridge Research Center; Army Map Service; U.S. Weather Bureau; EG and G	4
Los Alamos Scientific Laboratory Test Group			
11.2	Radiochemistry Sampling	4926th Test Squadron (Sampling)	12
University of California Radiation Laboratory Test Group			
21.2	Sample Collecting	4926th Test Squadron (Sampling)	3
Civil Effects Test Group			
39.6	Measurement of Initial and Residual Radiations by Chemical Methods	Army Signal Engineering Laboratories	5

* Unknown

Preshot surveying, construction of instrumentation mounts, and installation and checking of gauges for Shot POST probably took six project personnel two weeks. Postshot recovery of data was probably accomplished on shot-day at the stations farthest from ground zero, where radiation intensities were negligible, by two individuals in four hours. Recovery of the data from the stations closest to ground zero was probably accomplished by three individuals in the two days following the detonation, when the area was declared radiologically safe (81; 86; 132).

Project 2.1, Gamma Exposure versus Distance, was performed to evaluate the neutron-induced gamma radiation exposure potential at various distances from the nuclear detonation. Film packets were located at 29 stations along a line in the predicted upwind sector of the shot area. The closest station was 920 meters from the shot-tower, and the farthest was 3,290 meters from the shot-tower. At 0715 hours, one hour after the Test Manager declared that recovery operations could begin, a party of about three project personnel, in coordination with Project 2.2 and CETG Project 39.6, began to collect dosimeter packets from the instrument line. One radiological safety monitor was furnished by Army Signal Corps Engineering Laboratories to accompany the recovery team (46; 81; 86).

Project 2.2, Neutron Flux Measurements, was designed to evaluate the neutron radiation at various distances from a nuclear detonation. To accomplish this objective, a team of five, traveling in one vehicle, arrayed neutron detectors on three lines running west, south, and southwest of the shot-tower to a distance of 1,100 meters. Following this activity, which would have taken one or two hours, the personnel probably returned to Camp Mercury.

Because neutron detectors had to be analyzed as soon after exposure as possible, the Test Manager permitted Project 2.2

recovery teams to enter the shot area behind the initial radiological survey team at 0455 hours, 25 minutes after the detonation. Two two-man teams, each accompanied by a radiological safety monitor, were scheduled to recover the detectors. After completing this activity, which would have taken about one hour, project personnel returned immediately to Camp Mercury with their detectors (49; 81; 86).

Project 2.3b, Gamma Radiation Fields Above Fallout-contaminated Ground, appears to have been conducted at Shot POST. The Test Director's schedule of events stated that at 0900 hours on the day prior to the event, three project personnel in a Navy spectrometer van were to study the residual gamma-ray spectrum in the vicinity of the northeast-southwest access road to Area 9. One individual in a separate vehicle was to accompany the van and reenter the area as required to maintain the spectrometer in operating condition. Project personnel were to return to the Control Point area by 1630 hours (81; 86; 99).

Project 2.7, Shielding Studies, was conducted to investigate the shielding afforded against gamma and neutron radiation by foxholes, an M48 tank, and field fortifications located around the shot-tower.

On the day before the shot, four project personnel in one vehicle were scheduled to spend about 90 minutes assembling the project stations while another team of three individuals instrumented six foxholes with gamma and neutron detectors. The one-man and two-man foxholes were positioned 270, 540, and 900 meters in a line southwest of the shot-tower. The project personnel placed three film badges in each foxhole and posted gamma and neutron radiation detectors three feet above ground at these locations to record radiation intensities outside the foxholes. This task probably took about 90 minutes to complete.

At 0715 hours on shot-day, one hour after recovery operations were permitted, a team of three individuals in one vehicle were scheduled to recover the radiation detectors located in the foxholes. A radiological safety monitor provided by Project 2.7.1 accompanied this recovery party, which spent about 90 minutes recovering film badges. Film badges were also recovered from the field fortifications after the detonation.

In addition to the foxhole shielding studies, studies were made on an M48 tank which was instrumented with National Bureau of Standards/Evans Signal Laboratory film badges prior to the shot and subsequently retrieved by project personnel after the detonation. Neither the location of the tank nor the number of personnel who recovered the film badges is known (29; 81; 86; 133).

Project 2.8a, Contact Radiation Hazard Associated with Contaminated Aircraft, was designed to determine the contact-radiation exposure potential associated with working on aircraft that had flown through a nuclear cloud. Standard gamma survey meters were held near the contaminated components of the aircraft to record radiation dose rates. As many as five project personnel took part in the radiological surveys, which were conducted immediately after the AFSWC cloud-sampling aircraft had returned to Indian Springs AFB and continued up to 24 hours thereafter. A description of project procedures appears in the TEAPOT Series volume (13; 26; 81; 86).

Project 3.1, Response of Drag-type Equipment Targets in the Precursor Zone, was designed to test the capability of vehicles to withstand the destructive pressures present in the precursor zone of the blast front created by a nuclear detonation. Instead of vehicle targets, Q gauges and pressure-time gauges were used at Shot POST. Before the shot, project personnel placed the gauges near the shot-tower to obtain data on blast pressure. The

gauges were retrieved over a period of several days after the shot (9; 81; 86).

Project 6.3, Missile Detonation Locator, evaluated a tactical-range radar system used to determine the location of a nuclear detonation by analysis of the characteristic electromagnetic pulse emitted. The detonation locator consisted of broad-band receivers set up in California on baselines approximately 110 and 320 kilometers southwest of the NTS. Radio links between the stations provided the time comparisons necessary to determine relative time of arrival at each station. No onsite fielding activities have been indicated in available documentation for this shot, although project personnel typically gathered baseline data from a station located near the control point during other test events (81; 86; 101).

The objective of Project 6.4, Test of IBDA Equipment, was to gather engineering evaluation data for an Indirect Bomb Damage Assessment (IBDA) system installed in a B-50D aircraft. The system consisted of the standard radar set, AN/APQ-24; an experimental radar set, AN/APA-106 (XA-1); a light and time recording set, AN/ASH-4 (A-1); and a K-17 aerial camera. A second objective was to determine the maximum operating range of the AN/ASH-4 recording set, the yield-measuring component of the system. This was accomplished by placing one recording set and one A-4 bomb-spotting camera in each of two F94 aircraft.

The B-50 staged out of Kirtland AFB and probably had a crew of ten. Since engineering evaluation tests were being conducted, one additional engineer and one technician accompanied the crew to monitor and ensure the operation of the IBDA system. The B-50D, simulating a weapons-delivery mission, was positioned by radar navigation between three and seven nautical miles from ground zero at the time of the detonation. The two F-94s, each

with a crew of two, staged out of Indian Springs AFB. Radio navigational aids of the Air Operations Center positioned the aircraft about 140 and 180 kilometers from ground zero, at altitudes of 30,000 and 35,000 feet, respectively. At least one crew member of each aircraft wore a film badge (28; 35; 81; 86).

Project 8.4d, Spectrometer Measurements, was designed to measure changes in the thermal radiation produced by a nuclear detonation. The recording spectrometer and project personnel were in Building 410, situated near the Control Point at Yucca Pass (81; 86; 109).

Project 8.4f, Bolometer Measurements, was designed to determine the distribution of thermal radiation as a function of time during a nuclear detonation. As with Project 8.4d, all project activities were performed at Building 410 (67; 81; 86; 108).

Project 9.1, Technical Photography, was not performed at Shot POST. One C-47 aircraft usually photographed the detonation from the air. Since this aircraft was also scheduled to photograph the MET detonation, which was being considered for firing at 0900 hours later on the same day, the aircraft could not fly both missions. Air photography of the POST event was thus cancelled (33; 35).

Project 9.4, Atomic Cloud Growth Studies, photographed the development of the nuclear cloud. The project was conducted from a manned camera station, probably located 21 kilometers south-southeast of ground zero. The two-man team that occupied this camera station entered the shot area two hours before the detonation, and was scheduled to remain at the station through the shot and leave the area no later than one hour after the detonation (35; 48; 81; 86).

6.2.2 Department of Defense Participation in LASL and UCRL Test Group Projects

Two AEC nuclear weapons development laboratories participated in Shot POST. The LASL Test Group conducted nine projects, and the UCRL Test Group conducted eight.

Of the LASL projects, DOD personnel participated only in Project 11.2, Radiochemistry Sampling. Of the eight UCRL projects, DOD personnel participated in Project 21.2, Sample Collecting. LASL Project 11.2 and UCRL Project 21.2 were performed by aircraft of the AFSWC 4926th Test Squadron (Sampling). These projects are discussed in section 6.2.5 of this chapter.

6.2.3 Department of Defense Participation in CETG Projects

CETG conducted four projects at Shot POST. As shown in table 6-1, only one of these projects, Project 39.6, Measurement of Initial and Residual Radiations by Chemical Methods, included DOD involvement. The objectives of Project 39.6 were to compare data on various methods of gamma radiation measurement, and to obtain dosimetric data at stations where various biological investigations were being conducted. Project 39.6 personnel assisted in Military Effects Group Projects 2.1 and 2.2 by recovering dosimeters from stations located 360 to 1,10 meters northeast of ground zero. At recovery hour, three project personnel drove to Area 9 to recover the dosimeters, which would have taken about one hour. A radiological safety monitor was provided by Project 39.6 to accompany this recovery team. DOD participation included five project personnel from the Evans Signal Laboratory of the Army Signal Engineering Laboratories, but it is not clear whether these DOD personnel took part in field operations at Shot POST (24; 123).

6.2.4 Department of Defense Operational Training Projects

The Air Force conducted two operational training projects at Shot POST, and the Navy conducted one:

- Project 40.6, Calibration of Electromagnetic Effects
- Project 40.8, Calibration of Bomb Debris
- Project 40.10, Delivery Crew Indoctrination.

Project 40.6, Calibration of Electromagnetic Effects, was conducted by Air Force personnel. Its objective was to expand existing information on the characteristics of the electromagnetic pulse emitted by a nuclear detonation. At 0900 hours on the day before the detonation, two individuals in a helicopter left station 40.6b on Yucca Lake, 19 kilometers south of ground zero, to service eight sets of unmanned recording equipment located 10 to 20 kilometers from the shot-tower. This activity required about four to six hours to complete. At 0130 hours on shot-day, two individuals arrived at station 40.6c, about 11 kilometers west of ground zero, at UTM coordinates 755109, to operate equipment until one hour after the detonation. In addition, a three-man team was positioned at station 40.6b, to operate equipment until two hours after the shot (3; 86; 105; 106).

Project 40.8, Calibration of Bomb Debris, which was also conducted by Air Force personnel, was designed to determine the relative yields of nuclear products and residues for use in characterizing nuclear weapons. Project participation was integrated with the AFSWC sampling missions sponsored by UCRL Project 21.2, and is discussed in the following section of this chapter (35; 105; 106).

Project 40.10, Delivery Crew Indoctrination, was conducted by the Navy. Fourteen F-84 aircraft were scheduled to participate in this event, although eight did not fly the mission as planned. The other six aircraft performed a flyby maneuver near ground zero at shot-time, and then returned to their staging base

at San Diego, California. Each F-84 had one pilot (3; 35; 105; 106).

6.2.5 Air Force Special Weapons Center Activities

AFSWC supervised air activities through its Air Operations Center, which exercised operational control of all aircraft participating in the tests at the NTS. In addition, AFSWC personnel conducted cloud-sampling missions, courier service activities, cloud-tracking missions, and aerial surveys of terrain.

Cloud sampling, which was conducted for LASL Project 11.2, UCRL Project 21.2, and Air Force Project 40.8, enabled AEC and DOD scientists to obtain and analyze samples of the nuclear cloud. AFSWC courier services involved the delivery of the samples to the nuclear weapons development laboratories and military research and development laboratories. Cloud tracking not only allowed the Test Manager to plot the course of the nuclear cloud, but also helped the Civil Aeronautics Administration to divert commercial aircraft from the cloud path. Terrain surveying allowed the Test Manager to monitor the test areas exposed to cloud fallout.

Listed on the following page are the types and numbers of aircraft and estimated numbers of AFSWC aircrew personnel involved in air missions at Shot POST (35). With the exception of the B-50 cloud-tracking aircraft, which staged out of Kirtland AFB, AFSWC aircraft originated from Indian Springs AFB.

PROJECT	TITLE	TYPE OF AIRCRAFT	NUMBER OF AIRCRAFT	NUMBER OF PERSONNEL
11.2/	Sampling			
21.2/	Sampler Control	B-50	1	9
40.8	Sampler	F-84G	6	6
	Courier Service	C-119	2	8
		C-47	2	6
	Cloud Tracking	B-25	1	5
	Aerial Surveys of Terrain	C-47	1	3
		H-19	3	15

Cloud Sampling

In conjunction with LASL Project 11.2, UCRL Project 21.2, and Air Force Project 40.8, six F-84G aircraft, with one pilot each, performed cloud sampling at Shot POST. One B-50, with a UCRL technical dvisor and a crew of eight, served as sampler control. In all, the samplers collected a dozen filter paper samples. The operation was routine for the most part, although one sampler aircraft sustained a tire blowout on landing at Indian Springs AFB. No damage to the aircraft resulted.

During the mission, the F-84Gs collected samples at altitudes between 6,000 and 14,000 feet. The first sampler began cloud penetration one hour after the detonation, and the last began two hours and 28 minutes after the detonation. The following listing summarizes the six sampling missions.

AIRCRAFT	NUMBER OF PENETRATIONS	TOTAL TIME IN CLOUD (minutes: seconds)	HIGHEST INTENSITY (R/h)
F-84G #028	3	3:10	70
F-84G #043	5	2:35	25
F-84G #032	4	2:00	15
F-84G #033	5	2:30	11
F-84G #053	3	5:25	15
F-84G #051	2	8:35	*

*Unknown

The B-50 sampler control aircraft landed soon after the last sampler aircraft at Indian Springs (35; 38).

Courier Service

After the POST event, four aircraft were used to transport samples to agencies and laboratories throughout the U.S. One C-119 left Indian Springs AFB with samples for Oakland Municipal Airport, and subsequent delivery to UCRL. A second C-119 left Indian Springs AFB at 1106 hours for McClellan AFB with samples destined for analysis as part of Air Force Project 40.8. A C-47 left Indian Springs at 1125 hours for Kirtland AFB with samples for LASL. The final aircraft, a C-47, left Indian Springs AFB at 1214 hours with a load enroute to Bolling AFB. This last aircraft carried soil samples for Naval Research Laboratory Project 2.2 (35; 38).

Cloud Tracking

Due to the low altitude of the top of the POST cloud, 15,000 feet, the B-25 conducting the cloud-tracking mission flew between

13,000 and 15,000 feet. The aircraft tracked the nuclear cloud south to a point approximately 27 kilometers southwest of Indian Springs AFB (35 - 38).

Since wind shear was nonexistent and wind velocity was low, breakup of the cloud did not occur and the tracker aircraft crew was able to maintain visual contact throughout the mission (35).

Aerial Surveys of Terrain

A routine low-level terrain survey mission was performed by a C-47 aircraft flying 300 to 500 feet above the ground. Three H-19 helicopters also assisted in the survey. No increase above background radiation was detected (35; 38).

6.3 RADIATION PROTECTION AT SHOT POST

The purpose of the various radiation protection procedures developed for Operation TEAPOT was to ensure that personnel exposure to ionizing radiation was as low as possible, while allowing participants to complete their tasks. Some of the procedures described in the Series volume resulted in records which enabled Exercise Desert Rock, the JTO, and AFSWC to evaluate the effectiveness of their procedures. Such records for Shot POST have been located only for the JTO. The JTO Onsite Radiological Safety Organization was staffed by the Army 1st Radiological Safety Support Unit, from Ft. McClellan, Alabama, and was managed by the Armed Forces Special Weapons Project (AFSWP). The following descriptions detail these activities, including dosimetry, use of radiological safety equipment, survey methods, isointensity plots, and decontamination records. Other than the Final Dosage Report, no records of Exercise Desert Rock VI or AFSWC radiological safety activities have been located.

Dosimetry Records

From 8 through 13 April 1955, the period including Shot POST on 9 April, the Dosimetry and Records Section issued 592 film badges and 146 pocket dosimeters. Film-badge readings indicate that during this time 12 individuals accumulated gamma-radiation exposures which resulted in cumulative exposures greater than 2.0 roentgens but less than the JTO-authorized limit of 3.9 roentgens (19).

Six AFSWC pilots flew F-84G aircraft for cloud sampling during Shot POST. Film-badge readings for these individuals ranged from 0.3 to 0.6 roentgens of gamma radiation for the POST sampling missions (35).

Logistical Data for Radiological Safety Equipment

The General Supply Division of the Logistics Section issued 308 pieces of protective clothing and 20 respirators during the period of Shot POST. In addition, the Instrument Repair Section issued 205 radiological survey meters during Shot POST (19).

Monitoring Activities

On shot-day at 0432 hours, two minutes after detonation, the initial survey party, probably consisting of four or five two-man teams, checkpoint parties, and road patrols left the Control Point at Yucca Pass. They began their surveys at 0455 hours, 25 minutes after detonation. The initial survey was completed by 0600 hours. A copy of the initial isointensity map is shown in figure 6-1. Because the winds were calm to 13,000 feet, local fallout deposition was probably not complete by the time the initial survey was performed (19).

It was necessary to locate the checkpoint, which was established at 0445 hours, south of Areas 1 and 3 because of fallout in areas near BJY. Thirty minutes after detonation, the north

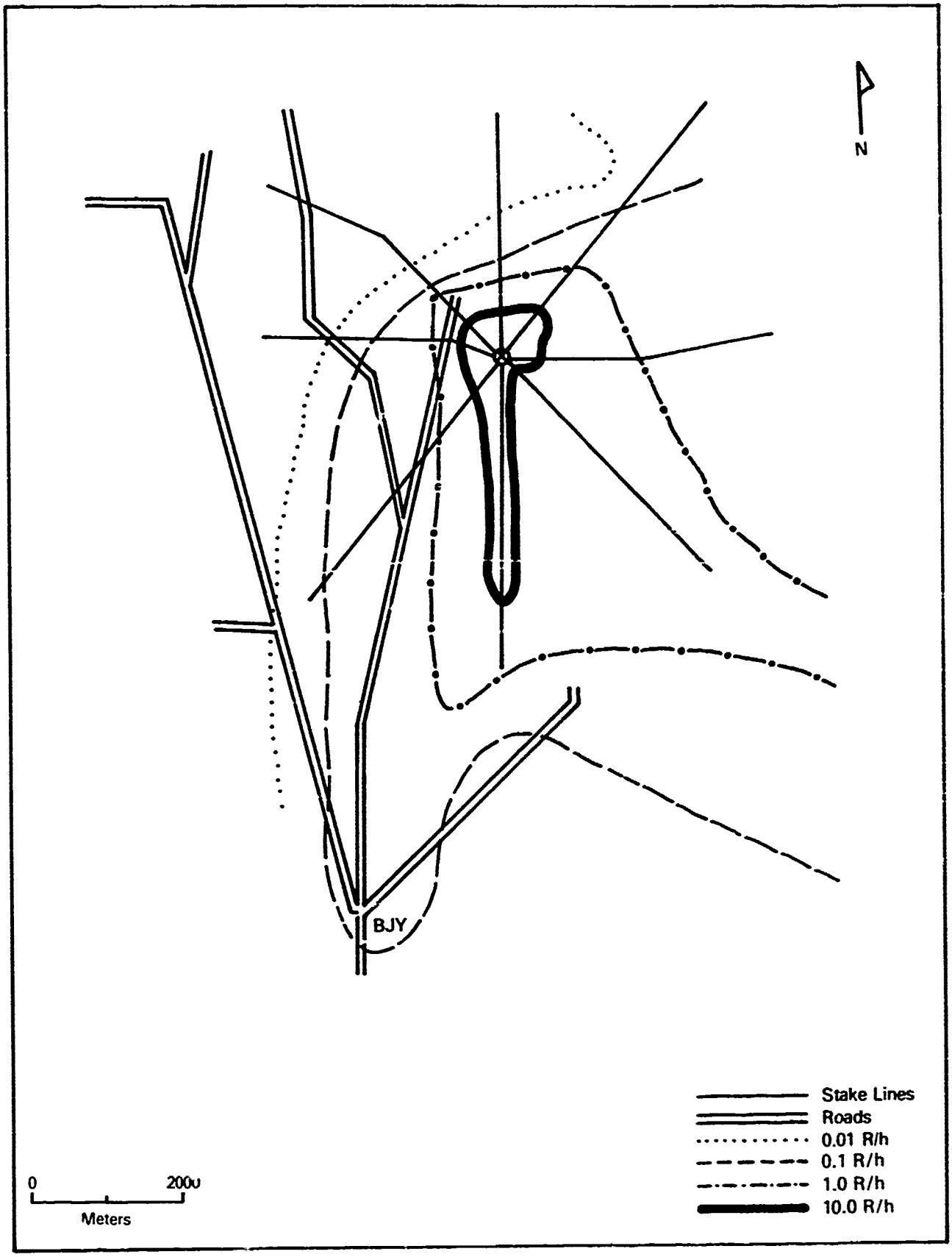


Figure 6-1: INITIAL SURVEY FOR SHOT POST, 9 APRIL 1955, 0455 TO 0600 HOURS

road patrol reported an intensity of over 0.2 R/h at BJY. At this time, a monitor was dispatched to the main access road at Yucca Airstrip to report periodic intensity readings, which showed no radiation above background. Signs were posted on all access roads by 1030 hours. Resurveys of the test area were conducted on 11, 12, and 21 April, and 4 May. Copies of the isointensity maps generated from the resurveys are shown in figure 6-2. The average exposures for the initial survey and first resurvey teams were 0.64 and 0.21 roentgens, respectively (19).

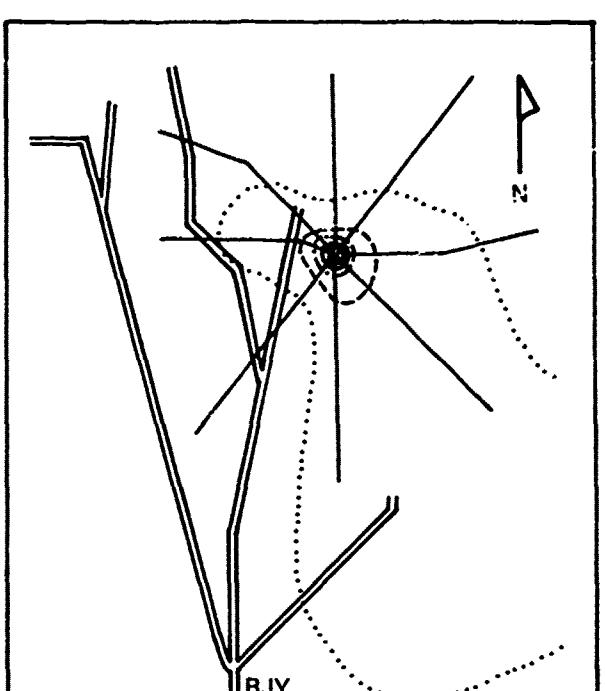
In addition to the ground survey, three H-19 helicopters, each with a crew of five, conducted aerial surveys of the POST ground zero area.

Recovery and Re-entry Procedures

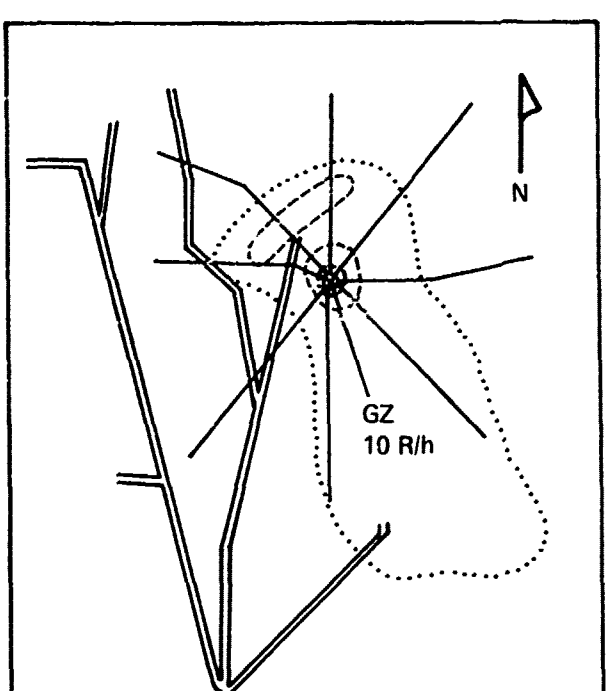
Because a new tower was being constructed near BJY and Area 7 for Shot ZUCCHINI, frequent intensity readings were furnished to the Test Director. The reading at BJY rose as high as 0.2 R/h, and intensities rose as high as 2.0 R/h in Area 7. As a result, construction in Area 7 was discontinued from POST shot-day until 11 April, when the radiation level had dropped to 0.03 R/h.

The following parties were cleared for entry into radiation areas during Shot POST (19; 75).

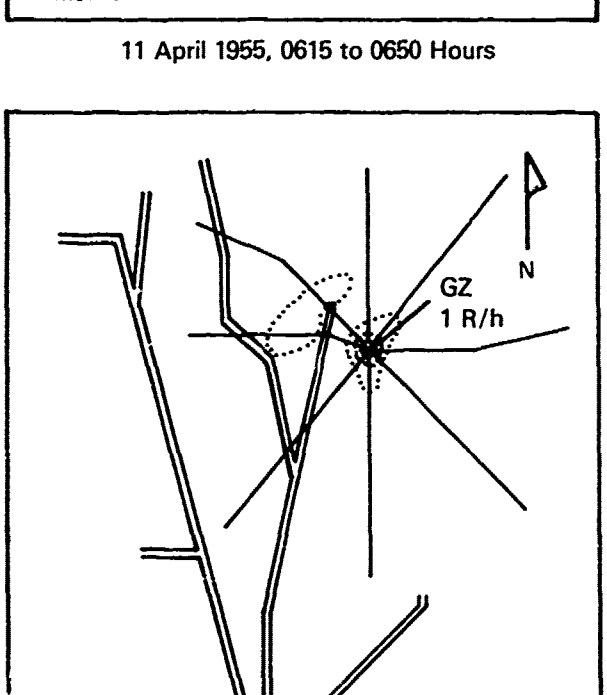
DATE	NUMBER
9 April	10
10 April	2
11 April	9
12 April	3
13 April	10
14 April	4
TOTAL	38



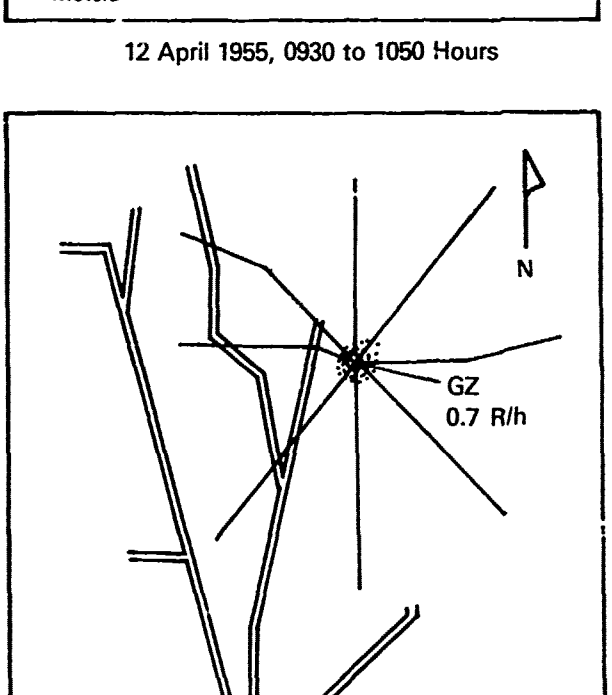
11 April 1955, 0615 to 0650 Hours



12 April 1955, 0930 to 1050 Hours



21 April 1955, 0930 to 1050 Hours



4 May 1955, 0935 to 1030 Hours

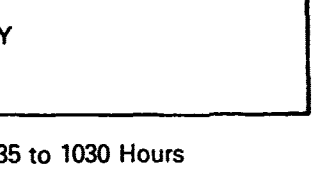


Figure 6-2: RESURVEYS FOR SHOT POST

Decontamination

During the period including Shot POST, 8 through 13 April 1955, 31 vehicles and 50 other items of equipment required decontamination. In addition, four vehicles and 17 other items of equipment were placed in the "hot park" until radiation intensities decayed to acceptable levels (19).

MET

SHOT SYNOPSIS

AEC TEST SERIES:	TEAPOT
DOD EXERCISES:	Desert Rock VI
DATE/TIME:	15 April 1955, 1115 hours
YIELD:	22 kilotons
HEIGHT OF BURST:	400 feet (tower shot)

DOD Objectives: (1) To study the effects of a nuclear weapon on military equipment
(2) To allow DOD personnel to observe a nuclear detonation.

Weather: At shot-time, temperature at shot height was 18.5° C; pressure at 880 millibars; winds from the south-southwest, 14 knots at the surface, 32 knots west-southwest at 20,000 feet, and 73 knots west-southwest at 40,000 feet.

Radiation Data: Onsite fallout greater than 0.01 R/h occurred primarily northeast of ground zero, extending no farther than 1,500 meters southwest of ground zero. During the initial survey, taken between 1150 and 1305 hours, onsite fallout of 10.0 R/h was detected around ground zero. Fallout of 0.01 R/h and greater extended northeast of the shot.

Participants: Atomic Energy Commission, Exercise Desert Rock participants, Armed Forces Special Weapons Project, Air Force Special Weapons Center and other Air Force personnel, Los Alamos Scientific Laboratory, Federal Civil Defense Administration, contractors, DOD laboratories.

CHAPTER 7

SHOT MET

Shot MET, the twelfth nuclear test of Operation TEAPOT, was detonated on 15 April 1955 at 1115 hours in Frenchman Flat, located in the southeastern part of the Nevada Test Site (NTS), at UTM coordinates 956728. Shot MET was the only event in the TEAPOT Series that was not detonated in Yucca Flat. Sponsored and developed jointly by the Los Alamos Scientific Laboratory (LASL) and the Armed Forces Special Weapons Project (AFSWP), MET was detonated from a 400-foot tower and produced a nuclear yield of 22 kilotons. The MET nuclear cloud top reached a height of 40,300 feet. Fallout was deposited in a narrow band northeast of the point of detonation (30; 41).

Shot MET, an abbreviation for Military Effects Test, had the largest number of Military Effects Group projects of the TEAPOT Series. Department of Defense (DOD) participants also took part in Exercise Desert Rock activities, scientific experiments of other test groups, and support missions, as described in this chapter. Figure 7-1 displays the location of DOD personnel in the shot area at the time of the detonation. An account of the radiological situation created by Shot MET, along with the procedures used to minimize the exposure of DOD participants to ionizing radiation, is summarized at the end of the chapter.

7.1 EXERCISE DESERT ROCK VI OPERATIONS AT SHOT MET

Desert Rock exercise troops took part in one troop test and seven technical service projects at Shot MET. In addition, Camp Desert Rock support troops observed the MET detonation as part of the Desert Rock Troop Orientation and Indoctrination Program. Table 7-1 lists Desert Rock VI activities at MET, presenting the

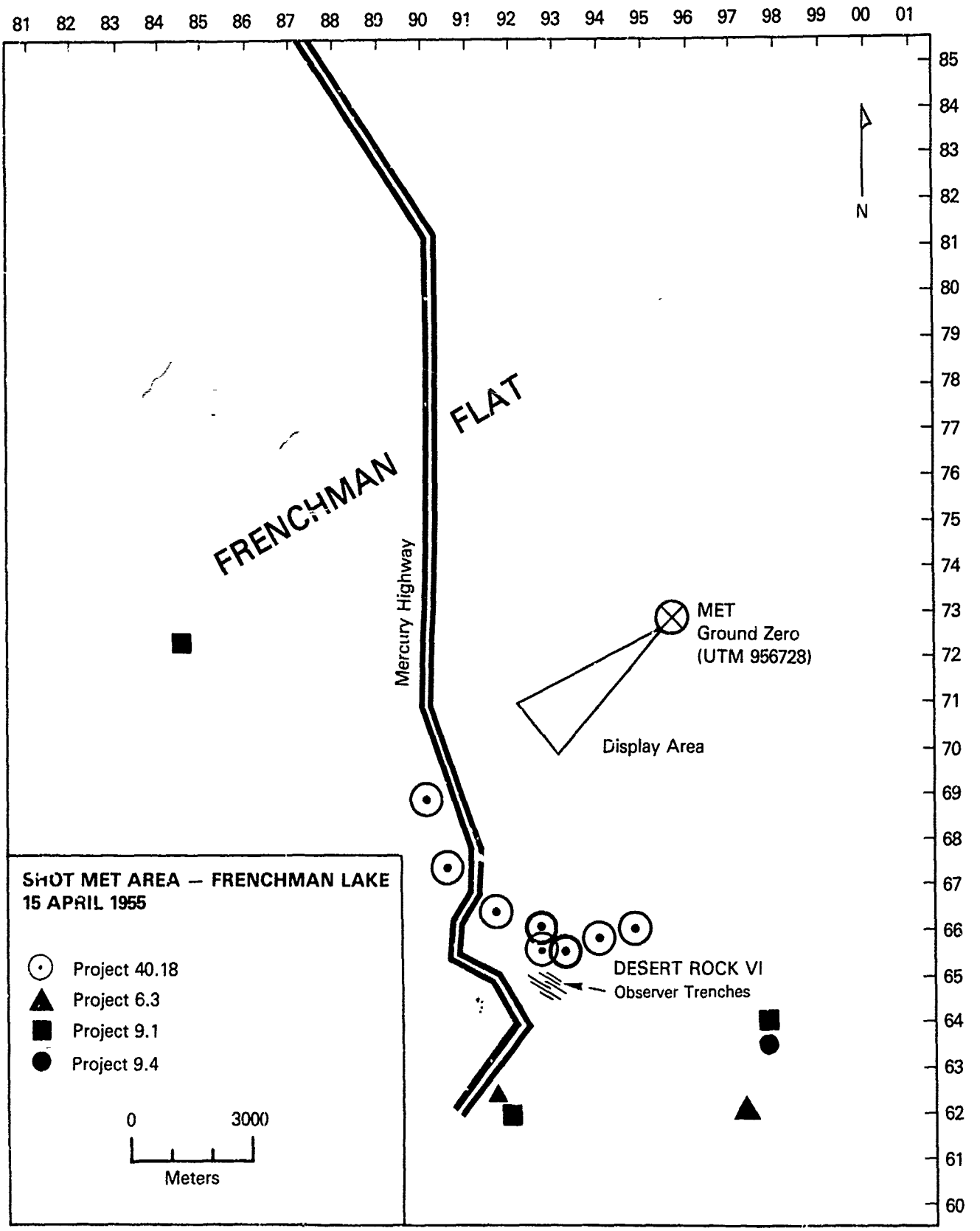


Figure 7-1: FORWARD POSITIONS OF DOD PERSONNEL AT SHOT-TIME FOR MET

Table 7-1: EXERCISE DESERT ROCK VI PROJECTS, SHOT MET

Program Type	Project	Title	Estimated Personnel	Participants
Troop Orientation and Indoctrination	—	Camp Desert Rock Observers	163	Camp Desert Rock Support Troops
Troop Test	40.18	Location of Atomic Bursts	48	Battery C (-), 532nd Field Artillery (Observation) Battalion
Technical Service	40.14	Chemical, Biological, and Radiological Defense Shelters Test	*	Chemical Warfare Laboratory; Engineer Research and Development Laboratory
	40.15	Engineer Field Fortifications and Equipment Test	*	Engineer Research and Development Laboratory
	40.15a	Engineer Heavy Equipment Test	*	Engineer Research and Development Laboratory
	40.17	Effects on Steel Transporters or Containers	3	Army Transportation Research and Development Command
	40.19	Sixth Army CBR Defense Team Training	22	Sixth Army
	40.20	Clothing Test — Thermal Protection Afforded by Land Forces' Environmental and Gas Protective Clothing	*	Quartermaster Research and Development Center
	40.21	Ordnance Vehicular Equipment Test	*	Ballistic Research Laboratories; 573rd Ordnance Company; Detroit Arsenal

* Unknown

numbers and titles of the programs and projects, the project sponsors, the estimated numbers of DOD participants, and the service units involved in the projects.

7.1.1 Troop Orientation and Indoctrination Program

A significant observer program had been planned for MET. Military observers received a preshot tour of the equipment display area on 10 April 1955, almost a week before the shot. However, because of the potential hazard presented by the use of a drone aircraft in the vicinity of the MET shot-tower, the extensive observer plans for MET were canceled (43; 54).

The only observer group to participate during MET was an estimated 163 support troops from Camp Desert Rock, who witnessed the shot about 9.5 kilometers southwest of the shot-tower. Figure 7-2 shows Desert Rock personnel observing the MET detonation. Following the detonation, the observers boarded trucks and returned to Camp Desert Rock, 11 kilometers south of the observer location (43; 54).

7.1.2 Troop Test

Only one troop test, Project 40.18, Location of Atomic Bursts, was conducted at Shot MET. The Artillery School conducted the project, which employed an estimated 48 participants from Battery C (-), 532nd Field Artillery (Observation) Battalion. The objectives of the project were to test equipment and train troops to locate and determine the yield of a nuclear detonation. The surveys were carried out with AN/TVS-1 cameras, MK-11 Bhangmeters, AN/MPQ-21X radar sets, and sound microphones. Project personnel manned nine survey stations arrayed at various distances from ground zero to approximate the standard deployment

Figure 7-2: DESERT ROCK PERSONNEL OBSERVE MET DETONATION IN FRENCHMAN FLAT

of an observation battery under tactical conditions. The nine stations were at the following locations (85):

STATION	UTM Coordinates
Sound Control Point 2	805565
Station Location 6	901686
Station Location 5	905671
Station Location 4	916664
Station Location 3	927658
Flash Control Point	928657
Sound Control Point 1	928657
Station Location 2	940656
Station Location 1	945657

Documentation does not indicate when personnel assumed or left their positions at the station. During most previous shots, however, the stations were occupied at 1630 hours on the day before the shot (54; 59).

7.1.3 Technical Service Projects

As indicated in table 7-1, seven technical service projects were conducted at Shot MET, the most extensive participation of the Desert Rock Technical Service Program during Operation TEAPOT.

Project 40.14, Chemical, Biological, and Radiological Defense Shelters Test, was conducted by the Chemical Warfare Laboratories and the Engineer Research and Development Laboratories. The objective was to evaluate the effects of the blast wave on developmental chemical, biological, and radiological (CBR) defense techniques used with field bunkers and foxholes. The unmanned bunkers were located 420 meters from the shot-tower, while the foxholes, also unmanned, were situated head-on and side-on at distances from 450 to 1,800 meters from the shot-tower.

The number of personnel involved in Project 40.14 has not been documented. Although their specific activities and the time spent in the forward area also have not been documented, project personnel were most likely responsible for preparing and retrieving instruments and for inspecting the bunkers and foxholes (54).

Projects 40.15, Engineer Field Fortifications and Equipment Test, and Project 40.15a, Engineer Heavy Equipment Test, were sponsored by the Engineer Research and Development Laboratories. The objective of Project 40.15 was to determine the protection afforded against nuclear weapons by new field fortifications designed for conventional warfare. Project 40.15a was to test the degree of protection from nuclear weapons provided by below-ground emplacement of engineer equipment. The total number of military personnel who took part in these two projects has not been documented. Company A, augmented by one platoon from C Company, 95th Engineer Combat Battalion, did the construction work for the projects (54).

Project 40.15, Engineer Field Fortifications and Equipment Test, required that 20 structures be built 300, 345, and 420 meters from the shot-tower. The structures included nine wooden gun emplacements, seven timber shelters, two metal bunkers, and two prefabricated plywood domes. Project 40.15a, Engineer Heavy Equipment Test, required that engineer equipment be positioned in trenches 480, 630, and 810 meters from the shot-tower. The heavy equipment included tractors, graders, truck-mounted air compressors, truck-mounted cranes, and generators. All the equipment positions in Projects 40.15 and 40.15a were unmanned at the time of the detonation. The exact activities of project personnel before, during, and after the MET detonation have not been documented (54).

Project 40.17, Effects on Steel Transporters or Containers, was conducted by the Army Transportation Research and Development

Command. The objective of the project was to determine the amount of protection afforded to cargo shipments during a nuclear detonation by a variety of transporters or containers. The following types of cargo shipments were placed at various distances from ground zero:

- Transporter with cargo in wooden boxes
- Transporter with domestic packaged cargo in fiberboard boxes
- Wooden boxes on standard pallets
- Loose cargo in wooden boxes covered by canvas tarpaulines.

Six display stations were set up. Each station included two sets of the cargo shipments listed above. The stations were situated from about 1,020 to 2,510 meters from the shot-tower.

On the day of the MET detonation, 15 April, three individuals were scheduled to drive to station 4, which was about 1,580 meters from the shot-tower, to make a final check of instruments and to connect some electrical equipment. This assignment took about four hours and was completed about two hours before the detonation. Recovery operations have not been documented, but probably took place in the days following the test event, when radioactive contamination had decayed to low levels (54; 85).

Project 40.19, Sixth Army CBR Defense Team Training, was designed to train Sixth Army personnel in radiological defense monitoring. Available documentation on Project 40.19 at MET indicates only that the Army conducted an aerial survey involving an L-20 aircraft, a radiological safety monitor, and a pilot, and that 22 military personnel participated in the project (61).

Project 40.20, Clothing Test--Thermal Protection Afforded by Land Forces Environmental and Gas Protective Clothing, was fielded by the Quartermaster Research and Development Center.

The number of military personnel involved is not known. The purpose of Project 40.20 was to test the ability of American, Soviet, and Communist Chinese military uniforms and protective clothing to withstand thermal radiation emitted by a nuclear detonation. Three stations were established 1,800, 2,700, and 3,300 meters from the shot-tower. Nine mannequins fitted with uniforms, gas capes, reflective barriers, and standard ponchos, were placed at each station. After recovery operations were permitted, project personnel assessed the thermal damage to the stations and retrieved remnants of the uniforms (54).

Project 40.21, Ordnance Vehicular Equipment Test, was conducted by the Ballistic Research Laboratories. The objectives of Project 40.21 were to determine the effect of roll-over safety bars in minimizing damage to wheeled vehicles, to obtain experimental design data for the future development of ordnance equipment, and to investigate the shielding effect of armor against gamma radiation. The equipment was placed at various positions in the display area. The ordnance vehicles included tanks, armored infantry vehicles, self-propelled guns, 1/4-ton trucks, 2 1/2-ton cargo trucks, and 5-ton trucks. The principal participant in the project was the 573rd Ordnance Company, which fielded the test equipment. Detroit Arsenal personnel also assisted in the fielding of the test vehicles. Dosimetry data were recovered from the vehicles when the Test Manager declared the area open for postshot activities. The number of military personnel involved in Project 40.21 is not known (54; 102).

7.2 DEPARTMENT OF DEFENSE PARTICIPATION IN MILITARY EFFECTS, SCIENTIFIC, OPERATIONAL TRAINING, AND SUPPORT ACTIVITIES AT SHOT MET

In addition to the Exercise Desert Rock projects described in the previous section, Department of Defense personnel performed a variety of tasks during Shot MET that required them to enter the forward area before, during, or after the shot. The

Test Manager declared the area safe for recovery operations at 1245 hours, one and one-half hours after the detonation.

Department of Defense personnel performed the 38 projects sponsored by the Military Effects Group. DOD personnel also assisted in one project conducted by the LASL Test Group and three projects performed by the Civil Effects Test Group. In addition, the Air Force conducted five operational training projects at Shot MET and the Navy and Marine Corps each conducted one. The Air Force Special Weapons Center (AFSWC) flew support missions for the test groups and for the Test Manager.

Table 7-2 lists the Military Effects, LASL, and Civil Effects Test Group projects by numbers and titles, and identifies the fielding agencies and the numbers of DOD participants.

7.2.1 Department of Defense Participation in Military Effects Group Projects

The Military Effects Group conducted 38 projects at Shot MET, as listed in table 7-2. Because in most cases, many of the same individuals performed both pre- and postshot activities, estimates reflect the maximum number of DOD people who would have been involved in one aspect of the project. For example, if the project description states that 15 project personnel performed preshot activities and five performed postshot recovery, the estimate listed in the table would be 15.

Project 1.2, Shock Wave Photography, was designed to evaluate the progression of the blast wave produced by the nuclear detonation. A series of smoke trails was created by firing 16 smoke rockets about 910 meters beyond the shot-tower. Five unmanned camera stations were placed at distances ranging between 2.4 meters and 20 kilometers from ground zero. All but one of the cameras were outside the 0.01 R/h line established by the

Table 7-2: TEST GROUP PROJECTS WITH DEPARTMENT OF DEFENSE PARTICIPATION, SHOT MET

Project	Title	Participants	Estimated Personnel
	Military Effects Group		
1.2	Shock Wave Photography	Naval Ordnance Laboratory	4
1.5	Preshock Sound Velocities Near the Ground in the Vicinity of an Atomic Explosion	Naval Electronics Laboratory	2
1.10	Overpressure and Dynamic Pressure versus Time and Distance	Stanford Research Institute	20
1.11	Special Measurements of Dynamic Pressure versus Time and Distance	Sandia Laboratory	8
1.12	Drag Force Measurements	Naval Ordnance Laboratory	5
1.13	Dust Density versus Time and Distance in the Shock Wave	Chemical Warfare Laboratory	18
1.14a	Transient Drag Characteristics on Spherical Models	Ballistic Research Laboratories	26
1.14b	Measurements of Air-blast Phenomena with Self-recording Gauges	Ballistic Research Laboratories	10
2.1	Gamma Exposure versus Distance	Army Signal Engineering Laboratories	*
2.2	Neutron Flux Measurements	Naval Research Laboratory	*
2.6	Radiation Energy Absorbed by Human Phantoms in a Fission Fallout Field	Naval Medical Research Institute	8
2.7	Shielding Studies	Chemical Warfare Laboratory	15
2.8a	Contact Radiation Hazard Associated with Contaminated Aircraft	Air Force Special Weapons Center	5
2.8b	Manned Penetration of Atomic Clouds	Air Force Special Weapons Center	3
3.1	Response of Drag-type Equipment Targets in the Precursor Zone	Ballistic Research Laboratories	*
3.2	Study of Drag Loading of Structures in the Precursor Zone	Wright Air Development Center	10
3.4	Air Blast Effects on Underground Structures	Office of the Chief of Engineers; Ballistic Research Laboratories	5
3.6	Evaluation of Earth Cover as Protection to Underground Structures	Bureau of Yards and Docks	6
3.7	Effect of Positive Phase Length of Blast on Drag-type Structural Buildings	AFSWC; Wright Air Development Center	5
3.8	Test of Concrete Panels	Bureau of Yards and Docks	2
3.9	Response of Small Petroleum Products Storage Tanks	Wright Air Development Center	5
3.10	Structures Instrumentation	Ballistic Research Laboratories	4
5.1	Destructive Loads on Aircraft in Flight	Wright Air Development Center; Air Proving Ground	*
5.2	Effects on Fighter-type Aircraft in Flight	Wright Air Development Center	2
5.4	Evaluation of Fireball Lethality Using Basic Missile Structures	Wright Air Development Center	14

* Unknown

Table 7-2: TEST GROUP PROJECTS WITH DEPARTMENT OF DEFENSE PARTICIPATION, SHOT MET (Continued)

Project	Title	Participants	Estimated Personnel
	Military Effects Group		
5.5a	Effects of Nuclear Explosions on Fighter Aircraft Components	Wright Air Development Center; University of Dayton	11
5.5b	Thermoelastic Response of an Aluminum Box Beam	Wright Air Development Center; University of Dayton	4
6.1.1a	Evaluation of Miiitary Radiac Equipment	Army Signal Corps Engineering Laboratories	3
6.1.2	Accuracy of Military Radiacs	Naval Radiological Defense Laboratory	7
6.2	Effects on Selected Components and Systems	Army Signal Corps Engineering Laboratories	3
6.3	Missile Detonation Locator	Army Signal Corps Engineering Laboratories	3
6.4	Test of IBDA Equipment	Wright Air Development Center	16
6.5	Test of Airborne Naval Radars for IBDA	Bureau of Aeronautics	6
8.1	Measurement of Direct and Ground-reflected Thermal Radiation at Altitude	Bureau of Aeronautics	9
8.4b	Thermal Measurements from Fixed Ground Installations	Naval Radiological Defense Laboratory	3
8.4e	Air Temperature Measurements	Naval Radiological Defense Laboratory	8
9.1	Technical Photography	Lookout Mountain Laboratory; AFSWC; Air Force Missile Test Center; EG and G	6
9.4	Atomic Cloud Growth Study	Air Force Cambridge Research Center; Strategic Air Command; U.S. Weather Bureau; EG and G	4
	Los Alamos Scientific Laboratory Test Group		
11.2	Radiochemistry Sampling	Air Force Special Weapons Center	17
	Civil Effects Test Group		
37.1	Factors Influencing the Biological Fate and Persistence of Radioactive Fallout	Air Force Special Weapons Center	3
37.2	Phenomenology of Fallout at Near Distance	Air Force Special Weapons Center	3
39.6	Measurement of Initial and Residual Radiations by Chemical Methods	Army Signal Engineering Laboratories	5

* Unknown

initial radiological survey team on shot-day. Film was probably recovered on shot-day in three hours by four project personnel (80; 85; 103).

The objective of Project 1.5, Preshock Sound Velocities near the Ground in the Vicinity of an Atomic Explosion, was to measure the changes in the transmission of sound waves due to changes in air pressure associated with a nuclear detonation. Sonic velocities were measured over asphalt, water, concrete, and plant material. Reports furnished by the radiological safety monitors indicate that, following the detonation, project personnel entered the shot area on shot-day and on four other occasions over the next ten days to recover data and instruments. This work probably took two individuals two hours on shot-day, and four hours on each of the other four days (80; 85; 100).

Project 1.10, Overpressure and Dynamic Pressure versus Time and Distance, was designed to determine the increase in air pressure produced by a nuclear detonation over three surfaces: water, asphalt, and desert. One hundred twenty-three channels of instrumentation were placed at 52 stations and recording shelters ranged between 600 and 1,200 meters north and south of the shot-tower. Measurements of side-on and dynamic pressure were taken using a pitot tube gauge at three- and ten-foot elevations above the surface. Side-on pressure was also measured at ground level and ten feet above ground level, using a baffle mount.

Before the shot, it is estimated that 20 project personnel spent 15 days building the instrumentation shelters and installing the instrumentation. When recovery operations were permitted by the Test Manager, a team of three project personnel, accompanied by a radiological safety monitor, reentered the area to recover some data. This took approximately four hours. Later, six personnel probably spent a week completing the data recovery and removing the instruments and towers (80; 85; 116).

Project 1.11, Special Measurements of Dynamic Pressure versus Time and Distance, was conducted to measure pressure variations produced by a nuclear detonation over water, asphalt, and desert. Three blast lines were instrumented to measure after-flow direction, air and dust contributions to dynamic pressure, the effect of obstacle size on dynamic pressure, and density and velocity of air and suspended dust. On each of the instrument lines, twin three-foot towers were located at distances of 600 and 750 meters from the shot-tower. In addition, 61 gauges were positioned at ten stations ranging from 400 to 2,400 meters from the shot-tower. Before the shot, it is estimated that eight individuals worked for two weeks to survey the sites and to install the gauges. After the radiation levels in the area decreased sufficiently, five persons probably spent two days recovering the data and removing the instruments and towers (6; 80; 85).

Project 1.12, Drag Force Measurements, was designed to measure blast forces of the winds produced by a nuclear detonation. Spheres containing gauges capable of measuring the force of the blast in all directions were mounted three feet above the ground surface. Surveys, excavation, pouring of slabs, and installation of gauges probably took five personnel one week. The gauges and instrumentation were positioned between 600 meters and 1,350 meters south of the shot-tower. It is estimated that three individuals recovered the data three hours after the shot (80; 85; 92).

The objective of Project 1.13, Dust Density versus Time and Distance in the Shock Wave, was to determine pressure effects at various distances from a nuclear detonation over desert and asphalt. Beta densitometers were located 760 and 910 meters from the shot-tower on the desert and asphalt instrument lines. At each station, the detector units were housed within a streamlined concrete bunker. Dust-sampler equipment was placed on the asphalt surface at 610-, 760-, and 910-meter stations.

Before the shot, construction of the bunkers and instrumentation shelters, and installation of the gauges at the five stations probably took 15 project personnel two weeks. On shot-day, three radiological safety monitors were assigned to personnel from this project. A monitor and two project personnel probably went to each of the five stations for two hours to recover data. After recovery hour had been declared, six persons probably spent two days cleaning up the site (44; 80; 85).

Project 1.14a, Transient Drag Characteristics on Spherical Models, was very similar to Project 1.12 but was conducted by Ballistic Research Laboratories instead of the Naval Ordnance Laboratory. The project was designed to measure blast forces caused by a nuclear detonation, and project activities were similar to those of Project 1.12. It is estimated that before the shot 15 personnel were involved in construction activities for two weeks and ten individuals were involved in gauge installation, recording, and check procedures for one week. From one to ten days after the shot, the services of a radiological safety monitor were furnished to Project 1.14a, probably for eight hours, so that technicians could recover their data and instruments. After recovery hour was declared, six individuals probably spent two days cleaning up the project area (10; 80; 85).

Project 1.14b, Measurements of Air-blast Phenomena with Self-recording Gauges, measured pressure variations at one ground range along an arc using mechanical pressure-time gauges. Self-recording pressure-time gauges were installed 750 meters southwest of the shot-tower. Preshot surveying, construction of instrumentation mounts, installation, and checking of gauges probably took ten persons two weeks. On shot-day, four radiological safety monitors accompanied four project personnel for four hours while they recovered data. The remaining data and gauges were probably recovered by two persons within two days, after radiation intensities had decreased (80; 85; 132).

Project 2.1, Gamma Exposure versus Distance, measured initial gamma intensities at various distances from a nuclear detonation. The data obtained from these measurements could be used to predict and evaluate the gamma radiation hazard posed by certain nuclear devices. Measurements obtained from each shot were compared with measurements from devices detonated under similar circumstances, such as WASP and WASP PRIME.

At MET, gamma measurements were obtained using National Bureau of Standards (NBS) film dosimeters, each loaded with two film packets, which were placed on posts at a range of 460 to 2,730 meters from the point of detonation. Dosimeters were recovered as soon after the detonation as possible, so that the initial gamma radiation produced by the detonation of the device was the principal contributor to the badge reading and not augmented by gamma radiation from fallout or from radioactivity induced in the soil by the detonation (46; 80; 85).

Project 2.2, Neutron Flux Measurements, measured neutron radiation as a function of distance from a nuclear detonation. The data obtained from this experiment were to be used to predict and evaluate the hazard posed by neutron emissions during nuclear detonations. As in Project 2.1, measurements were compared with devices detonated under similar conditions.

At MET the detectors used to measure neutron intensities were placed in the field, either on stakes in the ground or attached to steel cables laid out in a line from ground zero.

Early recovery was a necessity for accurate evaluation of neutron activity. For measurements close to ground zero, the instruments were attached to a cable so that promptly after the shot the cable could be pulled out of regions of high radioactivity into areas of lower intensity, where samples could be removed and sent to the laboratory for analysis. For measurement

stations farther from the point of detonation, the instruments were placed on stakes. Following recovery, the detectors from this project were taken to Indian Springs AFB, where waiting AFSWC courier aircraft flew the samples to the Naval Research Laboratory for analysis (19; 80; 85).

Project 2.6, Radiation Energy Absorbed by Human Phantoms in a Fission Fallout Field, involved measuring radiation intensities of the fallout by placing masonite mannequins instrumented with radiation detectors at various stations within the fallout field following the detonation.

At 1245 hours on 15 April, the time designated by the Test Manager for recovery operations to begin, two teams, each consisting of four project personnel in two vehicles, entered the shot area and placed two mannequins near the 0.5 R/h line. It is estimated that the teams each spent about ten minutes in the fallout field. It is not known precisely when the teams returned to recover the mannequins for analysis. However, in light of standard operating procedures for this project at other nuclear events, it is likely that they made three separate trips into the shot area each day for three days after the detonation to record data, and recovered the equipment at the end of the third day, when radiation intensities had decreased substantially (65; 80; 85; 97).

Project 2.7, Shielding Studies, was designed to evaluate the effectiveness of structures and equipment in reducing gamma and neutron exposure potential. Field fortifications, corrugated steel structures, foxholes, vehicles, and other equipment were tested.

The project made use of 14 field fortifications which had been constructed by the Corps of Engineers for Projects 3.8a, 3.8b, and 3.8c during Operation UPSHOT-KNOTHOLE in 1953, and nine

corrugated steel shelters. The fortifications and shelters were instrumented with gamma dosimeters and neutron detectors in various locations to measure the amounts of shielding provided against radiation exposure. The fortifications and shelters varied in construction type and size and were located 300, 345, 420, and 570 meters southwest of the shot-tower.

Project personnel also instrumented 12 foxholes of varying sizes and orientations with gamma and neutron detectors placed at various depths. The foxholes were located 440, 675, 810, 1,350, and 2,700 meters southwest of the shot-tower (133).

Vehicles and equipment were also tested as part of Project 2.7. An M59 armored personnel carrier, located about 430 meters west of the shot-tower, was instrumented with film badges after the detonation. Dose-rate measurements were taken by project personnel from inside and outside the vehicle while it was still in a residual radiation field to determine the shielding afforded against residual radiation. A T97 self-propelled 155mm gun and three M48 tanks, probably placed near the M59 armored personnel carrier, were instrumented with film badges. Project personnel also took measurements after the shot to determine residual radiation levels and shielding effects.

Finally, project personnel instrumented three vehicle emplacement trenches with gamma-radiation and neutron detectors. One trench, probably located 480 meters southwest of the shot-tower, contained a tractor, a bulldozer, and a grader. A second trench, located about 630 meters southwest of the shot-tower, contained a tractor, a bulldozer, a grader, a truck-mounted crane, a generator, and a truck-mounted air-compressor. In the third trench, located about 810 meters southwest of the shot-tower, were placed a truck-mounted crane, a truck-mounted air compressor, and a generator. Before the shot, project personnel placed gamma and neutron detectors in the center of the

trenches located 480 and 630 meters from ground zero; the trench at 810 meters was instrumented with gamma-radiation detectors.

One hour after recovery operations were permitted, at 1345 hours, three teams, each consisting of four individuals in three vehicles, set out to recover the film badges and neutron detectors from the bunkers and foxholes southwest, from the armored vehicles 435 meters west, and from the vehicle trenches 480, 630, and 810 meters southwest of ground zero. The working time in the area is estimated to have been about 30 minutes. One radiological safety monitor accompanied each team. At the same time, three personnel recovered dosimeters from the foxholes located 440, 675, 810, 1,350, and 2,700 meters from ground zero (29; 80; 85; 133).

Project 2.8 consisted of two separate but related experiments: Project 2.8a, Contact Radiation Hazard Associated with Contaminated Aircraft, and Project 2.8b, Manned Penetration of Atomic Clouds.

Project 2.8a, Contact Radiation Hazard Associated with Contaminated Aircraft, was performed to assess the exposure potential presented by ground crew contact with an aircraft that had flown through a nuclear cloud. Standard gamma-survey meters were held near the contaminated components of the aircraft used in Project 2.8b to determine the radiation intensities of the aircraft. Several different types of meters were used and their readings were compared. Radiation-decay studies were conducted up to 24 hours after the detonation. The general procedures followed in conducting this project are described in the TEAPOT Series volume (26; 80; 85).

Project 2.8b, Manned Penetration of Atomic Clouds, was to measure the radiation dose received by Air Force personnel and

aircraft flying near and into the nuclear cloud. Specific information was sought by the Air Force on radiation dose rates inside the cloud, the total dose received during passage through the cloud, and the dose received on the return flight. Two T-33 aircraft instrumented with automatic recording dose rate meters, radiac meters, and film packets penetrated the cloud a number of times to record radiation levels. They then landed at Indian Springs AFB (13; 80; 85; 131).

Project 3.1, Response of Drag-type Equipment Targets in the Precursor Zone, was designed to determine the ability of vehicles to withstand the precursor-enhanced blast effects of a nuclear detonation. In the MET test area, blast lines were established down the centerline of asphalt, water, and desert surfaces. It was expected that a different type of blast wave would be noted over each surface due to the different precursor formations.

Vehicle targets were positioned on the surfaces at various distances from ground zero to compare the extent of damage. Thirty 1/4-ton trucks, some of which had sustained light damage from Project 3.1 activities at other shots, were exposed to the detonation. Twenty-four other vehicles were also exposed. In addition, a 1/4-ton truck was placed behind a bunker of sand to determine the ability of the sand to reduce blast damage. A similar test was conducted with a 1/4-ton truck placed side-on to the detonation with sand bags banked with dirt on either side. The vehicles were placed at locations ranging from 600 to 900 meters from the shot-tower. The vehicles exposed on asphalt were south, the vehicles exposed on water were north, and those on desert terrain were west of the shot-tower. The activities of project personnel in the vicinity of ground zero were limited to placing and retrieving vehicles and instruments (9; 80; 85).

When recovery operations were permitted at 1245 hours, two project personnel from Project 3.1 and one radiological safety monitor in one vehicle spent about 30 minutes recovering gamma radiation film badges 460 meters southwest of ground zero. This task was accomplished in conjunction with Project 2.7 recovery procedures (9; 80; 85).

The objective of Project 3.2, Study of Drag Loading of Structures in the Precursor Zone, was to determine the ability of concrete buildings to withstand the precursor-enhanced blast effects of a nuclear detonation. In preparing for the shot, ten project personnel probably spent two weeks instrumenting the test concrete buildings, located between 1,200 and 1,800 meters south of the shot-tower. Postshot recovery of data was probably accomplished by two or three individuals in one day sometime after recovery hour. Specific activities have not been documented for this project (80; 85; 117).

Project 3.4, Air Blast Effects on Underground Structures, was to assess the damage caused to underground concrete and steel structures by an aboveground nuclear detonation. The three identical structures tested had been used in Project 3.8 of the 1953 UPSHOT-KNOTHOLE Series. The test structures were reinforced-concrete boxes with a large number of simply supported steel beams serving as roof supports. The structures were positioned close together on an arc 270 meters from the shot tower, and covered with earth to depths of about one, four, and eight feet. Access to the structures was provided through vertical shafts extending to horizontal passages which lead into the structures. Ballistic Research Laboratories personnel placed a total of 42 electronic instruments, including accelerometers, deflection gauges, pressure gauges, and strain gauges, in these structures.

Personnel from this project did not reenter the shot area on shot-day. After the radiation levels decayed enough that no

protective clothing was necessary, an estimated five project personnel probably spent three days surveying and recovering data from the structures. Five AEC contractor personnel with bulldozers probably spent an additional two days cleaning up the area after this project (80; 85; 128).

Project 3.6, Evaluation of Earth Cover as Protection to Underground Structures, was designed to determine the effectiveness of covering shelters with dirt as shielding against the blast and radiation effects of a nuclear detonation.

The main structure tested was a 7.5- by 14.5-meter steel-arch ammunition shelter. Another structure which had been constructed for UPSHOT-KNOTHOLE Project 3.15 was also tested. This building was also a 7.5- by 14.5-meter steel-arch structure. In addition to the two full-scale structures, six models were also tested. All of these were scaled to approximately one-quarter the size of the main test building and were constructed of corrugated sheet metal. Three of the models were steel and three were aluminum. Two models were located 460 meters from the shot-tower, two more were located 610 meters from the shot-tower, and the remaining four buildings were located 430, 700, 760, and 910 meters from the shot-tower. Nine self-recording air-pressure gauges, seven scratch gauges, and three types of radiation detectors were installed at two locations in each of the eight buildings.

Project participants did not reenter the area on shot-day. After the radiation levels decreased to a level requiring no special precautions, an estimated six project participants probably spent two days surveying and recovering data from the project. Ten AEC contractor employees probably spent a week cleaning up the area after the test (80; 85; 124).

Project 3.7, Effect of Positive Phase Length of Blast on Drag-type Structural Buildings, was conducted to determine the ability of differently constructed buildings to withstand the pressure and blast effects of a nuclear detonation.

The structures used in Project 3.7 were of two types. Structures 3.7a were steel frames 6.1 meters high, 12.2 meters wide, and 24.4 meters long, covered wi .h siding and roofing. These structures were located 1,100 meters and 1,330 meters south of the shot-tower. Structures 3.7b had the same steel frames and roofing as structures 3.7a, but were covered with a blast-resistant concrete siding. These structures also had a window equal to approximately 30 percent of the full wall area. Structures 3.7b were located 1,520 meters and 1,750 meters south of the shot-tower.

Project personnel did not reenter the area on shot-day. When radiation levels had decreased, an estimated four project participants and a photographer probably spent three days surveying and recovering data from test structures (80; 85; 119).

Project 3.8, Test of Concrete Panels, was designed to determine the ability of reinforced concrete buildings to withstand the pressure and blast forces of a nuclear detonation. Ribbed and solid panels were positioned 1,070 and 1,480 meters from the shot-tower. Measurements were made of the pressure, deflection, acceleration, and strain sustained by the panels during the detonation.

Project participants did not enter the area on shot-day. When radiation levels pe mitted activity in the vicinity of ground zer>, an estimated two project personnel probably spent two days surveying and recovering data from the test panels (2; 80; 85).

Project 3.9, Response of Small Petroleum Products Storage Tanks, was to determine the ability of containers used to store petroleum products to withstand the pressure and blast effects of a nuclear detonation.

Four tanks available from Operation UPSHOT-KNOTHOLE, which were essentially undamaged, were relocated at various distances from the shot-tower and filled to 80 percent capacity with water. No roofs were provided for three of the tanks that were of welded construction. The fourth tank, of bolted construction, was complete with the original UPSHOT-KNOTHOLE roof.

Project participants were not scheduled to reenter the area on shot-day. After the shot, when radiation levels permitted, an estimated four project personnel accompanied by a photographer surveyed and photographed the damage over an eight-hour period (80; 85; 104).

Project 3.10, Structures Instrumentation, was conducted to determine the loading and response of a blast wave on test structures by measuring pressures, accelerations, displacements, and strains. The project was to determine the response of above- and below-ground test structures to the blast and shock forces caused by a nuclear detonation.

Sixteen test structures were designed and built by participants from Projects 3.2, 3.4, 3.7, and 3.8 of Operation TEAPOT. Most structures were located between 1,000 and 1,800 meters south of the shot-tower. Instrumentation was provided by Project 3.10 personnel.

Project participants did not enter the area on shot-day. Later, when the radiation levels had decreased, an estimated four project participants probably spent three days surveying and recovering data from the test structures (80; 85; 96).

Project 5.1, Destructive Loads on Aircraft in Flight, was conducted to determine the ability of various aircraft structures to survive the gust loading produced by a nuclear detonation. Equipment used to record data for this experiment was tested at Shot BEE on 22 March. The full experiment was performed at Shot MET with three QF-80K drone aircraft. Accurate positioning of the three drone aircraft for this shot was one of the major operational problems. During the test participation flights at Shot BEE, on 22 March, each drone was controlled by a DT-33 director aircraft with a crew of two. A second DT-33 aircraft was assigned to each drone as a spare. The same configuration was probably used for the drone aircraft during the MET event.

At MET, each drone was flown independently in a left-hand holding pattern. At blast-wave arrival, the first drone aircraft was at an altitude of 8,860 feet. The second drone was at an altitude of 8,015 feet and a slant range of 1,380 meters from the point of detonation. The third aircraft was at an altitude of 7,330 feet and a slant range of 1,170 meters from the detonation. The presence of these three radio-controlled drones in the air and the uncertainties concerning their behavior following the detonation and blast-arrival was the principal reason for the cancellation of the large Desert Rock observer program that had been planned for the MET event (54; 80; 85; 111).

Project 5.2, Effects on Fighter Type Aircraft in Flight, was designed to determine the ability of jet-fighter aircraft to survive the blast forces produced by a nuclear detonation. Two F-84 aircraft flew set patterns at two different altitudes. The first aircraft was oriented in a level flight altitude, tail-on to the blast. At detonation, it was at a slant range of 4,030 meters and at an altitude of 9,960 feet. The second aircraft was positioned in a level flight altitude to receive symmetrical and asymmetrical side-on inputs from the blast. At detonation, it was at a slant range of 5,400 meters and at an altitude of 7,850

feet. Additional details concerning project activities, which were similar at several test events, are included in the TEAPOT Series volume (80; 85; 112).

Project 5.4, Evaluation of Fireball Lethality Using Basic Missile Structures, was conducted to determine the ability of various missile shapes and materials to survive the high temperatures produced by a nuclear detonation. Eight project participants probably spent five weeks before the scheduled event erecting the towers that were to be used as test structures. Construction and installation of other test materials probably required two weeks of effort by six personnel. The towers and other test materials were positioned from two to four kilometers northeast of the shot-tower.

On shot-day, two radiological safety monitors were assigned to the recovery crew. It is estimated that four project personnel required five hours each to rope off and examine the areas around their experiments. After recovery hour was declared by the Test Manager, four project personnel probably spent two days each examining the recovery area (80; 85; 91).

Project 5.5a, Effects of Nuclear Explosions on Fighter Aircraft Components, was designed to determine the structural response of fighter aircraft stabilizers and structural components to the blast forces produced by a nuclear detonation. In preparation for this project, a number of project personnel spent several weeks in Frenchman Flat performing a variety of tasks. Five individuals spent two weeks surveying the locations, pouring concrete slabs, and mounting aircraft stabilizers and baffle plates at these locations. An additional five individuals spent an estimated two weeks building mounts and installing oscillographs and other instrumentation, and placing 25 tons of lead shielding. Finally, four individuals probably spent four days constructing and installing cameras on three camera mounts.

On shot-day, two radiological safety monitors were assigned to personnel of Project 5.5a to allow them to recover their film and data from the recording oscillographs. This recovery operation probably took four project personnel two hours to complete. After radiation intensities in the area were surveyed and recorded, six personnel probably spent two days photographing and measuring the damage to the test items (80; 85; 127).

Project 5.5b, Thermoelastic Response of an Aluminum Box Beam, was conducted to determine the ability of aluminum aircraft components to survive the blast forces and high temperatures produced by a nuclear detonation. Before the shot, construction of an underground unmanned recording bunker, installation of recording equipment, and installation of the box-beam test item probably required a three-week effort from four participants.

After the shot, data were probably recovered in one hour on shot-day, by two project personnel and a radiological safety monitor. After radiation intensities in the area were determined, three individuals probably spent one day removing the box beam and the recording equipment (64; 80; 85).

Project 6.1.1a, Evaluation of Military Radiac Equipment, was to evaluate new radiation detecting instruments. To carry out this experiment, personnel placed dosimeters in tubes in 16 locations between 900 and 2,700 meters from the ot-tower. The dosimeters were recovered by three participan s, including a radiological safety monitor, approximately two hours after recovery operations were permitted by the Test Manager, or about three hours and 30 minutes after the detonaton.

To obtain residual fallout measurements, about four hours after the detonation three individuals placed additional dosimeters in a radiation field sufficient to give from 200 to 240 roentgens by the time they were recovered 24 hours later. Three

project participants spent one hour recovering the dosimeters one day later (15; 80; 85).

Project 6.1.2, Accuracy of Military Radiacs, was designed to measure the error factor of standard military radiac instruments by comparing them, under field conditions, with laboratory gamma-ray standards. A second objective was to measure the directional properties of gamma radiation emitted from a fallout field. Through close coordination with the Joint Test Organization (JTO) Onsite Radiological Safety Support Unit and with prior approval of the Test Manager, project participants were permitted to enter fallout areas as early as 1150 hours, 35 minutes after the detonation and almost one hour before the Test Manager permitted standard recovery operations for other projects. These initial entries were followed by others at 1215, also before recovery hour, and at 1315 and 1615 hours. In the first entry, a team of four project personnel followed directly behind the initial radiological safety survey party and proceeded to an area with radiation levels of approximately 3.0 R/h, stopping there to take readings on 25 instruments of five different types. The accompanying radiological safety monitor assisted project participants as the fifth member of the team.

In addition to the radiac-reading crews, two other personnel set up a directional radiation detector, and adjusted the detector for automatic scan. Because early entries were made with this detector, the total setup time was reduced to less than five minutes.

At all times when crews were working in radiation areas, extra evacuation vehicles were provided. Team operations were observed through field glasses from outside the radiation area, so that assistance could be provided in any emergency (80; 85; 129).

Project 6.2, Effects on Selected Components and Systems, was fielded to evaluate radiation effects on electronics equipment in both operating and storage conditions. The components investigated included electron tubes, crystal units, and radar beacons. The equipment was first tested at the APPLE 1 event, at 405 and 495 meters from ground zero. The yield on this event was somewhat lower than had been anticipated, requiring the crystals and electron tubes to be re-exposed at a later event. Accordingly, the project was again fielded at MET (80).

Some components were exposed 405 meters from the shot, and others 495 meters from the shot. It is estimated that before MET, three project personnel and two AEC contractor employees worked a total of two days to prepare the revetments and secure the component containers to the ground. Recovery operations were conducted in the days following the nuclear test, when radiation intensities had decayed to low levels (47; 80; 85).

Project 6.3, Missile Detonation Locator, was designed to evaluate a tactical-range radar system used to determine the location of a nuclear detonation from analysis of the characteristic electromagnetic pulse emitted. The detonation locator consisted of broad-band receivers, which were set up on baselines approximately 110 and 320 kilometers southwest of the NTS, in California. It is estimated that three personnel manned the detonation locators from three hours before to two hours after the detonation. Although, during other shots, project personnel typically gathered some data from a station located near the Control Point, no pre- or postshot fielding activities were required at the NTS for this event (80; 85; 101).

Project 6.4, Test of IBDA Equipment, was designed to gather engineering evaluation data for an Indirect Bomb Damage Assessment (IBDA) system installed in a B-50D aircraft. The second objective was to determine the maximum operating range of the yield-measuring component of the system.

The B-50D IBDA system consisted of the standard radar set, AN/APQ-24; an experimental radar set, AN/APA-107 (XA-1); a recording set, light and time, AN/ASH-4 (XA-1); and a K-17 aerial camera. To accomplish the second objective, personnel instrumented each of two F-94 aircraft with one ASH-4 recording set and one A-4 bomb-spotting camera.

The B-50D staged out of Kirtland AFB and normally had a crew of ten. Since engineering evaluation tests were being conducted, one additional engineer and one technician accompanied the crew to monitor and ensure the operation of the IBDA system. The F-94s staged out of Indian Springs AFB with two crewmen each. The B-50D, which was positioned by radar navigation, simulated an aircraft delivering a nuclear bomb. At shot-time, the B-50D was located from three to seven nautical miles from the shot-tower. The F-94s were positioned by the Air Operations Center at about 64 and 290 kilometers miles from ground zero. At least one crew member of each aircraft wore a film badge (28; 80; 85).

Project 6.5, Test of Airborne Naval Radars for IBDA, was designed to test the suitability of unmodified operational Navy radars for IBDA and to provide fleet personnel with experience in the analysis of IBDA data.

Two aircraft were flown in simulated attack configurations. The aircraft were AJ-2s, with a crew of three and one ASB-1 radar bombing system on board. At the time of detonation, the aircraft were on inbound headings approximately 11 kilometers from ground zero. Standard radarscope photography was used to record the presentations from the time of detonation until about ten seconds afterward. Following the detonation, the aircraft returned directly to their staging base in San Diego (80; 85; 130).

Project 8.1, Measurement of Direct and Ground-reflected Thermal Radiation at Altitude, was conducted to determine the

ability of Navy aircraft to withstand the thermal radiation produced by a nuclear detonation. An AD-5, an AD-4B, and an AD-6 flew in the vicinity of the detonation to record thermal radiation levels. At the time of detonation, the AD-5 aircraft was at a slant range of 4,500 meters and an altitude of 12,020 feet. The AD-4B was at a slant range of 4,470 meters from the burst and a height of 11,520 feet above the ground. The AD-6 aircraft, which flew in formation with the other aircraft, was positioned with radar at a slant range of 6,840 meters and an altitude of 12,020 feet. Following the detonation, the aircraft returned directly to their staging base (80; 85; 93).

Project 8.4b, Thermal Measurements from Fixed Ground Installations, was designed to measure and characterize the thermal radiation produced by a nuclear detonation at ranges that can cause damage to military equipment. The ground installations were located 60, 305, 610, and 760 meters from the shot-tower. Preshot selection of the sites and placement of the instrumentation probably took two personnel four hours. Postshot recovery of data was probably accomplished by two project personnel and a radiological safety monitor in one hour on shot-day. Recovery personnel working close to ground zero were suited in protective clothing and wore air-purification respirators (62; 80; 85).

The objective of Project 8.4e, Air Temperature Measurements, was to measure changes in air temperature during a nuclear detonation. In addition, the project measured radiant energy and irradiance as a function of time at three air-temperature instrumentation stations, located 300 meters south, west, and north of the shot-tower.

Before the shot, contractor personnel and about eight project personnel spent five and four weeks, respectively, surveying the locations, constructing recording shelters, towers, and various plots, and installing and checking the instrumentation of recording equipment.

Records indicate that a radiological safety monitor was assigned to Project 8.4e on shot-day, probably to accompany two project personnel for a period of four hours while data were recovered. Recovery of remaining data and site cleanup were accomplished after radiation in the shot area had decayed to negligible levels (66; 80; 85).

Project 9.1, Technical Photography, was designed to provide documentary photographs of the detonation.

Air participation for Project 9.1 included one RC-47 aircraft, which flew a six-minute holding pattern oriented from ten to 16 kilometers southeast of the shot-tower at an altitude of 8,000 to 10,000 feet. The RC-47, with a crew of three from AFSWC and about three photgraphers, was operated for the Lookout Mountain Laboratory by the Air Force and the Air Force Missile Test Center (33; 35; 80; 85).

Project 9.4, Atomic Cloud Growth Study, included DOD personnel in both ground and air operations. The objective was to study the development of the cloud produced by a nuclear detonation. The Army Map Service operated two camera stations for Project 9.4, one manned and the other unmanned. The stations were located 9.1 kilometers southeast and southwest of ground zero. Measurements on the rate of cloud rise and maximum cloud height were also taken at MET.

Air participation in Project 9.4 was performed by the Strategic Air Command (SAC), using two RB-47s. SAC was entrusted with an aerial photography mission sponsored by the Air Force Cambridge Research Center. SAC involvement in Project 9.4 was included as part of Project 40.5, and is detailed in Section 7.2.4 (35; 48; 80; 85).

7.2.2 Department of Defense Participation in LASL and UCRL Test Group Projects

Both the Los Alamos Scientific Laboratory (LASL) and the University of California Radiation Laboratory (UCRL) conducted experiments at Shot MET. Along with its contribution to the design of the MET nuclear device, the LASL Test Group conducted 12 projects at the shot. Of these projects, only Project 11.2, Radiochemistry Sampling, included DOD participants. Project 11.2, which was performed by sampling pilots of the AFSWC 4926th Test Squadron (Sampling), is discussed in section 7.2.5 of this chapter. DOD personnel did not participate in the one project performed by the UCRL Test Group at Shot MET.

7.2.3 Department of Defense Participation in CETG Projects

The Civil Effects Test Group (CETG) conducted eight projects at MET. Of these eight projects, three involved DOD personnel, as shown in table 7-2. AFSWC flew radio-relay missions for two CETG projects at Shot MET, as discussed in section 7.2.5 of this chapter (95).

Project 39.6, Measurement of Initial and Residual Radiations by Chemical Methods, was the third CETG project with DOD involvement at MET. This project was conducted in part by the Evans Signal Laboratory of the Army Signal Corps Engineer Laboratories. The objective of the project was to obtain dosimetric data at stations where various biological investigations were being conducted.

DOD participation in the project included five personnel from the Army Signal Engineer Laboratories, which supplied pre-shot data of use in determining the optimum locations for placing instruments to obtain the desired levels of gamma radiation exposure. DOD personnel also assisted in the field operations of station placement and recovery, and further aided by making

available a Cobalt-60 source for pre- and postshot instrument calibration (23; 123).

7.2.4 Department of Defense Operational Training Projects

Seven operational training projects were conducted at Shot MET (5):

- Project 40.1, Evaluation of IBDA Equipment and Techniques
- Project 40.4, Gust Effects on B-36 Aircraft
- Project 40.5, Reconnaissance Crew Indoctrination
- Project 40.6, Calibration of Electromagnetic Effects
- Project 40.8, Calibration of Bomb Debris
- Project 40.10, Delivery Crew Indoctrination
- Project 40.13, Tactical Indoctrination for a Marine Aircrew.

These projects were designed to test service tactics and equipment, and to train military personnel in the effects of nuclear detonations.

Project 40.1, Evaluation of IBDA Equipment and Techniques, trained SAC crews in aerial war tactics by simulating nuclear bomb delivery missions. Each of the four B-47s from Davis-Monthan AFB made a pass over ground zero at altitudes ranging from 34,000 to 39,000 feet. The aircraft entered the NTS at 1112 hours, three minutes before the detonation, flew its mission from 1112 to 1117 hours, and left the area at 1118 hours. The aircraft probably had a crew of four: a pilot, a co-pilot, a navigator/bombardier, and a radiological safety monitor (1; 3; 35; 105).

Project 40.4, Gust Effects on B-36 Aircraft, required the use of one B-36 aircraft operating from Carswell AFB. Its objective was to test the data on gust effects stated in the Strategic Air Command delivery capability handbook for the B-36 aircraft. Flying at 23,000 feet, the B-36 established a twelve- to fifteen-minute east-west holding pattern over ground zero at the time of detonation. The orbit was timed so that the aircraft was directly above ground zero when the blast wave arrived. After the passing of the blast wave, the aircraft returned to its home base. The plane probably carried a crew of 11 and a radiological safety monitor (1; 3; 35; 105).

Project 40.5, Reconnaissance Crew Indoctrination, provided photographic support for the Military Effects Group Project 9.4, while familiarizing Strategic Air Command crews with the effects of a nuclear detonation. Two B-47 aircraft, each with a pilot, a co-pilot, and a navigator/bombardier, flew directly over ground zero. One aircraft flew at 47,000 feet and the other at 43,000 feet. The aircraft, operating out of Forbes AFB, arrived in the NTS area at 1112 hours, took photographs from 1115 to 1117 hours, and left the area at 1118 hours (1; 3; 35; 105).

Project 40.6, Calibration of Electromagnetic Effects, was sponsored by the Air Force to obtain a greater understanding of the electromagnetic pulse emitted by nuclear detonations. According to the Test Director's Operation Plan 1-55 for MET, five men were scheduled to travel to a station on Yucca Lake 18 kilometers northwest of ground zero to set up project equipment at 0900 hours on 14 April, the day before the MET detonation. The men left before 1800 hours. At 0915 hours on shot-day, five men were to return to operate the station until one hour after the MET detonation at 1115 (1; 3; 35; 85; 105; 106).

Project 40.8, Calibration of Bomb Debris, was conducted by Air Force personnel to determine the relative yields of all

pertinent nuclear products and residues for use in characterizing nuclear weapons. Project participation was integrated with the AFSWC sampling missions conducted for LASL Project 11.2, which are discussed in section 7.2.5 of this chapter (1; 3; 35; 105).

Project 40.10, Delivery Crew Indoctrination, was designed to familiarize Navy personnel in the effects of a nuclear detonation on Navy aircraft. Eight AD aircraft, seven F-2H aircraft, two TV aircraft, and two AJ aircraft operating from San Diego, California, performed simulated weapons-delivery maneuvers at altitudes ranging from 24,000 to 34,000 feet. Their flight pattern consisted of establishing a holding pattern over Indian Springs AFB, and then passing over ground zero at 30 seconds before the detonation. The airplanes then turned to the right at the arrival of the blast wave. After the blast, they returned to their base at San Diego, California. Each AD, F-2H, and TV aircraft had a crew of two, while each AJ had a crew of three (1; 3; 35; 105).

Project 40.13, Tactical Indoctrination for a Marine Aircrew, allowed Marine Corps aircrews to experience the effects of a nuclear detonation. The project involved one AD aircraft, one R-5D aircraft, three F-3D aircraft, and two F-9F aircraft staging from the Marine Corps Air Station, El Toro, California. The aircraft circled at altitudes ranging from 15,000 feet to 24,000 feet and at locations between Lathrop Wells, Nevada, and Camp Desert Rock. The aircraft arrived in the NTS area at 1120 hours (1; 3; 35; 105).

7.2.5 Air Force Special Weapons Center Activities

AFSWC support to the JTO consisted of aircraft operational control, nuclear cloud-sampling missions, sample courier flights, cloud-tracking missions, and aerial surveys of terrain.

The following listing indicates the project, the mission, the types and numbers of aircraft, and the estimated numbers of AFSWC aircrew personnel flying support missions at MET (35 - 37):

PROJECT	MISSION	TYPE AIRCRAFT	NUMBER OF AIRCRAFT	DOD AIRCREW PERSONNEL
11.2/40.8	Cloud Sampling			
	Sampler Control	B-50	1	9
	Sampler	F-84G	6	6
		B-57	1	2
	Courier Service	C-119	2	8
		C-47	2	6
		B-25	1	5
	Cloud Tracking	B-50	2	24
		B-25	1	5
	Aerial Surveys of Terrain	C-47	2	6
		H-19	3	15

Cloud Sampling

Six F-84G aircraft and one RB-57 collected particulate and gaseous samples of the nuclear cloud for LASL Project 11.2, Radiochemistry Sampling, and Air Force Project 40.8, Calibration of Bomb Debris. A B-50 aircraft acted as the sampler control. A few difficulties occurred, including three faulty wing-tip ion chambers and a leak in the Integron radiation-detection equipment of one aircraft. One F-84G aircraft aborted its flight, but was replaced with a spare aircraft. The altitudes of the sampler aircraft ranged from 21,000 to 40,500 feet. The first sampler began collecting samples two hours and seven minutes after the detonation. The final three samplers began sample collection three hours after the detonation. The following listing presents information on the sampling missions of the F-84Gs (35; 38):

AIRCRAFT	NUMBER OF PENETRATIONS	TOTAL TIME IN CLOUD (minutes: seconds)	HIGHEST INTENSITY (R/h)
F-84G #032	2	3:25	25
F-84G #045	3	25:00	5
F-84G #051	1	4:25	12
F-84G #030	1	1:00	10
F-84G #054	1	30:00	0.7
F-84G #028	3	25:00	11
B-57 #419	4	2:40	32

Courier Service

Within seven hours after detonation, four aircraft left Indian Springs AFB to deliver samples. A C-119 departed for Kirtland AFB with samples for LASL. Another C-119 left for Oakland Municipal Airport with samples for UCRL. A C-47 departed for Kirtland AFB with materials for LASL, and a B-25 flew to Bolling AFB with soil samples for Naval Research Laboratory Project 2.2. Two days later, on 17 April, a C-47 flew to Friendship International Airport, Baltimore, Maryland, with additional material for the Naval Research Laboratory (35; 38).

Cloud Tracking

After the MET detonation, three cloud-trackers flew missions over and off the NTS. A B-50, probably with a crew of 12, flew at 28,000 feet; another B-50 also with a crew of 12, flew at 23,000 feet; and a B-25 with a crew of five, flew at 13,000 feet. The two B-50s were based at Kirtland AFB while the B-25 operated out of Indian Springs AFB. The aircraft followed the cloud

northeastward into Utah to a point approximately midway between Marysvale and Ferron, Utah (35; 38).

Aerial Surveys of Terrain

The aerial survey of terrain was accomplished by a C-47 aircraft flying at about 13,500 feet. This aircraft also performed a preshot ground-air relay mission for CETG Projects 37.1 and 37.2, as a communication link between the various project stations. A second C-47 conducted a low-altitude aerial survey three hours after detonation, at 1415 hours (95). Each plane operated out of Indian Springs AFB. Three H-19 helicopters were also involved in the surveying; they carried radiological safety monitors to areas which required radiological surveying (35; 38).

7.3 RADIATION PROTECTION AT SHOT MET

The purpose of the various radiation protection procedures developed for Operation TEAPOT was to ensure that individual exposure to ionizing radiation was as low as possible while allowing participants to accomplish the operational requirements of each activity or mission. Some of the procedures described in the Series volume resulted in records which enabled Exercise Desert Rock, the JTO, and AFSWC to evaluate the effectiveness of the procedures. Such records for MET have been located only for the JTO. The JTO Onsite Radiological Safety Organization, staffed by the Army 1st Radiological Safety Support Unit from Ft. McClellan, Alabama, was managed by AFSWP. The available JTO information, which will be presented in this section, includes film-badge data, logistical data on radiological safety equipment. survey results and records, isointensity pilots, and decontamination records. Other than the Final Dosage Report, no record of Exercise Desert Rock VI or AFSWC radiological safety activities has been located.

Dosimetry Records

From 14 April to 3 May 1955, which covers the 15 April detonation of MET, the Dosimetry and Records Section of the JTG issued 1,604 film badges and 796 pocket dosimeters (19).

Available film-badge readings indicate that during this time, for 55 personnel, the cumulative exposure exceeded two roentgens but was less than the JTO-authorized limit of 3.9 roentgens. Another 11 individuals had cumulative exposures exceeding 3.9 roentgens (19). Documentation for ten of these individuals has been found.

Three of the excessive exposures were received by military personnel involved in Project 2.7, Shielding Studies. Two individuals from the Chemical and Radiological Laboratory received exposures of 3.58 and 6.5 roentgens on shot-day, resulting in total exposures of 4.37 and 6.5 roentgens, respectively. The other individual, from the 2nd Chemical Weapons Battalion, received an exposure of 6.8 roentgens on shot-day, bringing his total exposure to 7.1 roentgens. These three participants were engaged in recovering fission neutron detectors from field fortifications located 345 and 420 meters from ground zero (18; 134).

Two civilians and two military personnel received excessive exposures during their work in Project 8.4. The two civilians were employees of the Naval Radiological Defense Laboratory, and they received exposures of 3.9 and 4.1 roentgens on shot-day, making their series total exposures 4.0 and 4.2 roentgens, respectively (16). The other two personnel were helicopter pilots, members of the 345th Troop Carrier Squadron. When these two pilots conducted a recovery mission for Project 8.4, they received about four roentgens of exposure. Upon completion of this mission, the Radiological Safety Officer directed them not to fly future missions over radiation areas. However, because no

other pilots or aircraft were available, the Radiological Safety Officer permitted them to fly an additional photographic mission for Program 1. The two pilots then had total exposures of 5.3 and 5.6 roentgens. These pilots were then prevented from participation in activities that would expose them to additional radiation (16; 18).

An officer from the Directorate of Weapons Effects Tests involved in Programs 2 and 8 received an exposure on shot-day of 3.7 roentgens, for a total of four roentgens (16). An individual from the 3080th Aviation Depot Group received a gammma exposure of 3.98 roentgens while participating at MET (16).

Finally, a member of the 1st Radiological Safety Support Unit accumulated a total exposure of 4.42 roentgens of gamma-radiation during his activities at Shot MET (16).

Logistical Data for Radiological Safety Equipment

The Logistics Section operated an issue station at the junction of the main access road to Frenchman Flat and Mercury Highway from 15 April through 25 April. The General Supply Section issued 1,692 pieces of protective clothing and 108 respirators during this period. In addition, the Instrument Repair Section issued 376 radiation survey instruments during this period (19).

Recovery and Re-entry Procedures

For Shot MET, an auxiliary plotting and briefing station was established at the intersection of the Frenchman Flat access road and Mercury Highway. This station was used to regulate access into the area by the people involved in the many military effects projects. This station was in position and functioning at 1135 hours, when the Test Director opened Mercury Highway to traffic. The Test Manager declared recovery operations could commence at 1245.

The Auxiliary Plotting and Briefing Section remained in operation from shot-day through 21 April. After that, the participation of recovery parties decreased so that it was not considered worthwhile to maintain a separate station. All parties entering the test area after 21 April were cleared at the Control Point (19).

The Plotting and Briefing Section cleared the following numbers of parties for entry into the MET test area (19; 75):

DATE	NUMBER OF PARTIES
15 April	25
16 April	37
17 April	22
18 April	35
19 April	35
20 April	33
21 April	17
22 April	5
23 April	2
24 April	2
25 April	5
26 April	2
27 April	1

In addition, 29 parties were cleared for entry into Yucca Flat areas during this same period

Monitoring Activities

For Shot MET the initial survey and checkpoint teams were split into groups. One group consisted of an area access checkpoint team and four monitoring teams that surveyed the northern stake lines 1, 2, 7, and 8. These groups left the Control Point at 1117 hours, two minutes after the detonation, proceeding south towards the MET test area in Frenchman Flat. The other group consisted of monitoring teams for stake lines 5 and 6, an area access team and a main checkpoint team, and a team to perform the auxiliary plotting and briefing and operate the auxiliary Dosimetry and Records Section. This second group left the control point area at the junction of Mercury Highway and the

Shot-Pole Road at 1117 hours, proceeding north towards the main access road to Frenchman Flat. The third group, consisting of a team monitoring stake lines 3 and 4 and the south area access checkpoint, also left the control point areas at 1117 hours, proceeding north (19).

All of the initial survey teams started at predesignated positions and awaited final instructions before beginning their surveys. The checkpoints were established by 1200, and the sign detail began positioning signs on access roads at 1300 hours. The onsite Radiological Safety Officer began releasing from the auxiliary checkpoint the teams at 1150 hours, and the entire survey was completed at 1305 hours. A copy of the initial isointensity map is shown in figure 7-3.

Resurveys of the test area were conducted on 16, 18, 20, and 26 April. Copies of the isointensity maps generated from these surveys are shown in figure 7-4. Average exposures for the initial survey and first resurvey teams were 0.44 and 0.24 roentgens, respectively. In addition to the ground surveys, three H-19 helicopters, each with a crew of five, were used to conduct aerial surveys of the ground zero area after the detonation.

In addition to the survey activities, monitors were provided to accompany project personnel into radiation areas. On shot-day, radiological safety monitors were provided for the following projects (19):

PROJECT	NUMBER
1.10	1
1.12	1
1.13	3
1.5	1
2.2	1
2.7.1	2
3.1	1
3.8	1
3.10.1	1
5.4	2

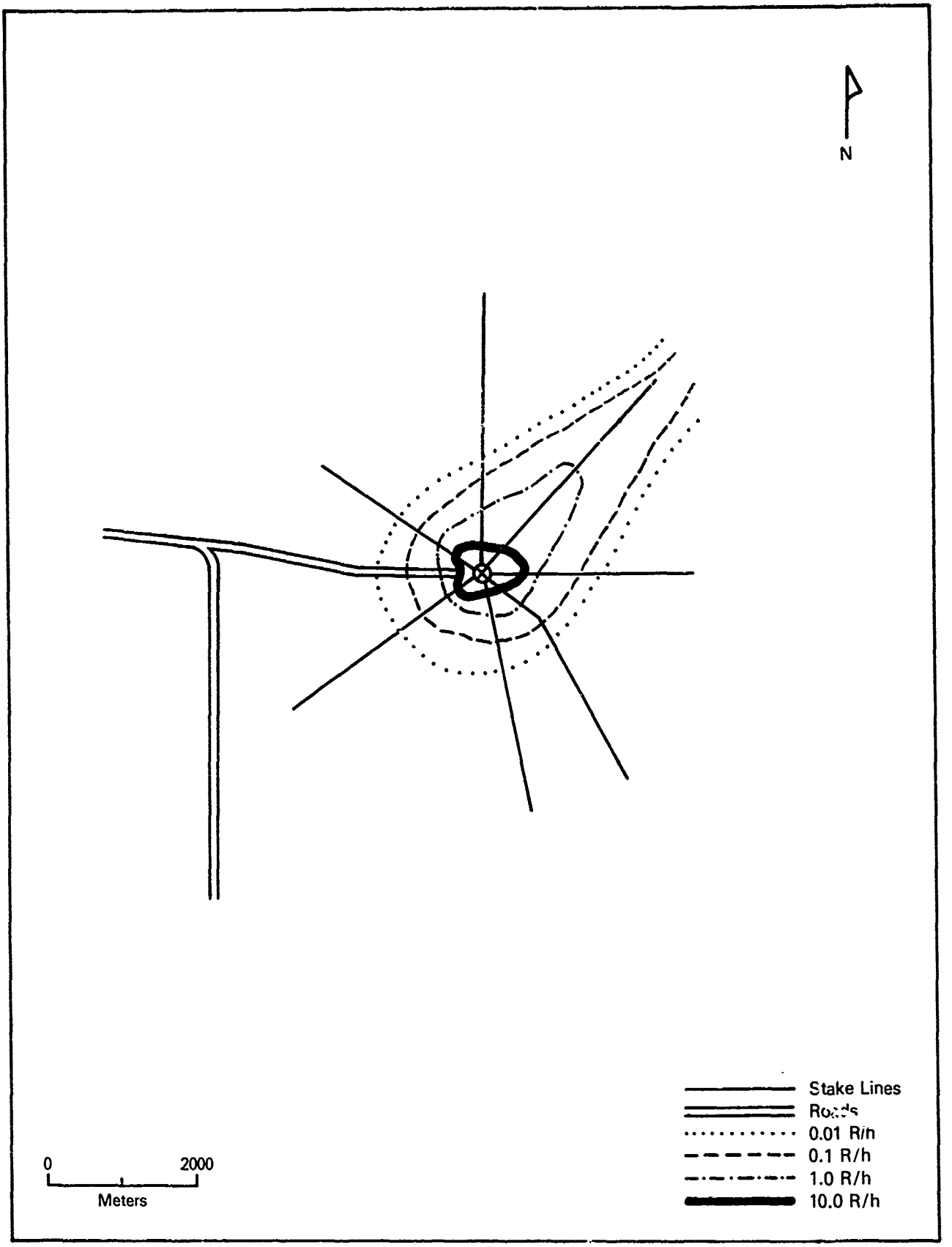
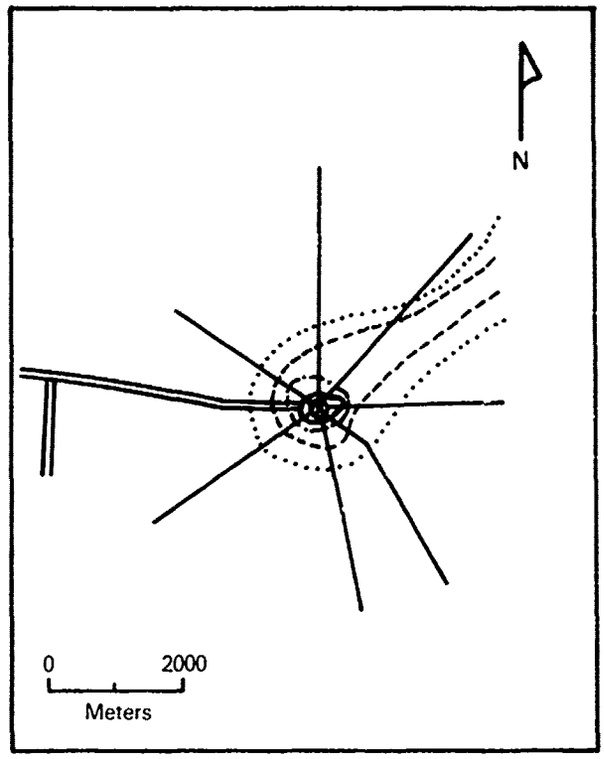
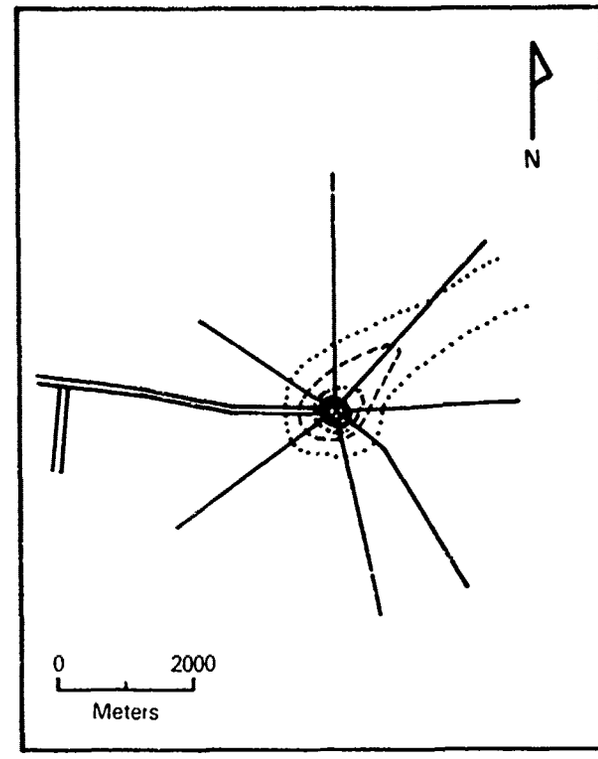


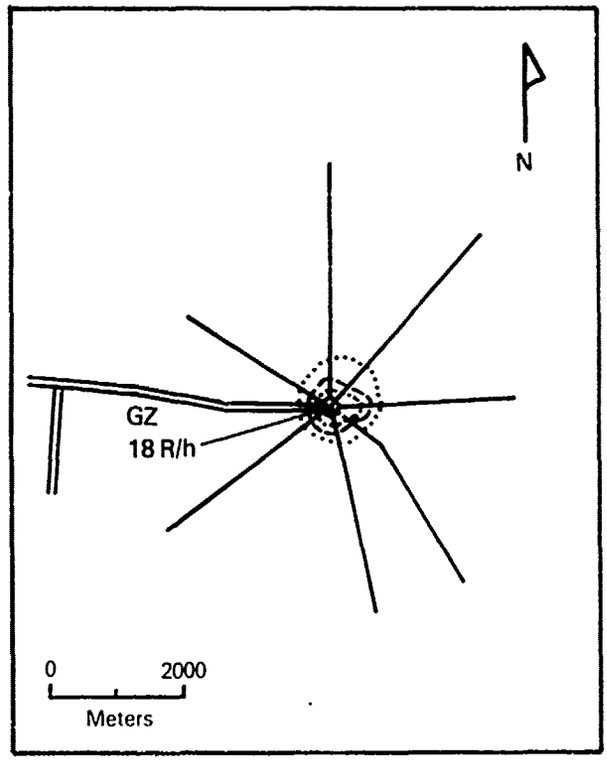
Figure 7-3: INITIAL SURVEY FOR SHOT MET, 15 APRIL 1955, 1150 TO 1305 HOURS



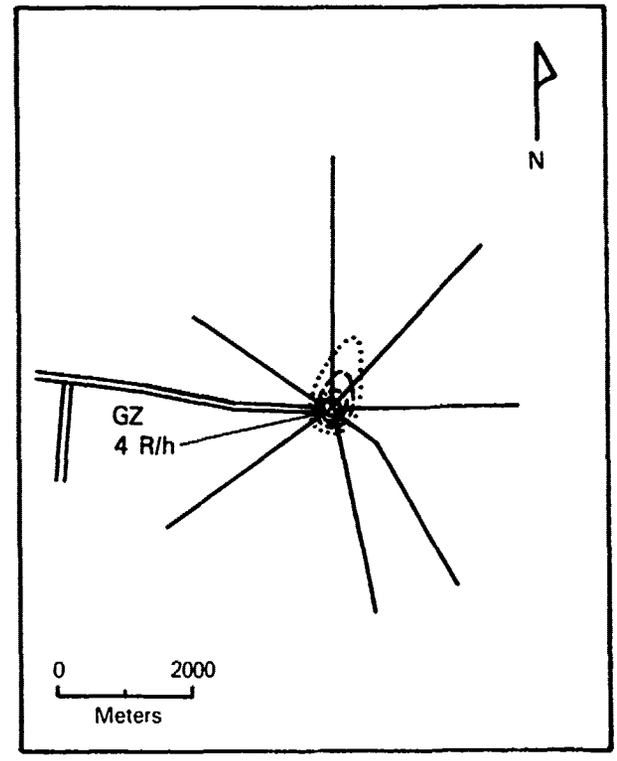
16 April 1955, 0520 to 0615 Hours



18 April 1955, 0635 to 0745 Hours



20 April 1955, 1015 to 1056 Hours



26 April 1955, 0910 to 0935 Hours

Stake Lines
Roads
0.01 R/h
0.1 R/h
1.0 R/h
10.0 R/h

Figure 7-4: RESURVEYS FOR SHOT MET

PROJECT	NUMBER
5.4/5.5	2
6.1.1	1
6.1.2	1
8.4	4
9	1
13.1	2
REECo Projects	2

During 16 to 26 April, the following radiological safety monitors were provided (19):

PROJECT	NUMBER
1.5	4
1.11	1
2.1	1
2.5.2	1
2.6	1
3	1
3.7	1
5.4	2
5.5	4
6.1.2	1
8.4	1
9	3
9.1	15

In addition, two monitors were provided for REECo Projects, and one each to the Test Director, the Director of Weapons Effects Tests, and the DOD Motor Pool.

Decontamination Activities

From recovery hour on shot-day until two days after detonation, a decontamination truck was stationed at the main access road to Frenchman Flat. This auxiliary station decontaminated and cleared seven vehicles for removal to Camp Mercury. In addition, 63 vehicles and 49 pieces of equipment were decontaminated at the decontamination station. An additional 13 items of equipment were placed in the "hot park" until radiation intensities decreased to predetermined acceptable levels (19).

ZUCCHINI

SHOT SYNOPSIS

AEC TEST SERIES:	TEAPOT
DOD EXERCISES:	None
DATE/TIME:	15 May 1955, 0500 hours
YIELD:	28 kilotons
HEIGHT OF BURST:	500 feet (tower shot)

Purpose of Test: To test a nuclear device for possible inclusion in the nuclear arsenal.

Objectives: To study the effects of a nuclear weapon on military equipment.

Weather: At shot-time, the temperature at shot height was 2.1° C.; pressure at 851 millibars; wind from the northwest at 11 knots at 10,000 feet and up to 68 knots from the west at 40,000 feet.

Radiation Exposure History: Onsite fallout greater than 0.01 R/h was detected southeast of ground zero during the initial survey, taken between 0832 and 0922 hours on shot-day. At that time, intensities of 10.0 R/h or greater were restricted to a circular area around ground zero.

Participants: Atomic Energy Commission, Armed Forces Special Weapons Project, Air Force Special Weapons Center and other Air Force personnel, Los Alamos Scientific Laboratory, contractors, DOD laboratories.

CHAPTER 8

SHOT ZUCCHINI

Shot ZUCCHINI, the fourteenth and final nuclear test of the TEAPOT Series, originally planned for 1 April 1955, was detonated on 15 May at 0500 hours, ten days after Shot APPLE 2. ZUCCHINI was detonated atop a 500-foot tower in Area 7 of the Nevada Test Site (NTS) at UTM coordinates 867056, and produced a nuclear yield of 28 kilotons. The ZUCCHINI nuclear cloud reached a height of 40,000 feet. Fallout began to appear southeastward toward Arizona, but southwesterly winds at higher altitudes caused a sharp turn in the fallout pattern northeastward into Utah (30; 41; 74).

Department of Defense (DOD) participants at Shot ZUCCHINI took part in scientific and military effects experiments, operational training projects, and support missions, as described in this chapter. Desert Rock exercises were not conducted at the shot. An account of the radiological situation created by Shot ZUCCHINI, along with the procedures used to minimize the exposure of DOD participants to ionizing radiation, is summarized at the end of the chapter.

8.1 DEPARTMENT OF DEFENSE PARTICIPATION IN MILITARY EFFECTS, SCIENTIFIC, OPERATIONAL TRAINING, AND SUPPORT ACTIVITIES AT SHOT ZUCCHINI

DOD personnel performed a variety of tasks during Shot ZUCCHINI that required them to enter the forward area before, during, or after the shot. The Test Manager declared the area safe for recovery operations at 0625, one hour and 25 minutes after the detonation. DOD personnel took part in six projects sponsored by the Military Effects Group, and two projects

sponsored by the Los Alamos Scientific Laboratory (LASL) Test Group. The University of California Radiation Laboratory (UCRL) Test Group performed one project at Shot ZUCCHINI, but this project did not involve DOD field participation. The Civil Effects Test Group also conducted four projects at Shot ZUCCHINI (25). According to the available documentation, DOD participation was not included in these projects. Originally the FCDA planned to make ZUCCHINI an open shot for the press and FCDA observers; however, this activity was rescheduled for APPLE 2 (11). Table 8-1 lists the test group projects by numbers and titles, and identifies the fielding agencies and the estimated numbers of DOD participants. In addition, DOD personnel conducted six operational training projects. The Air Force Special Weapons Center (AFSWC) provided air support to the test groups and to the Test Manager.

8.1.1 Department of Defense Participation in Military Effects Group Projects

The Military Effects Group conducted six projects at Shot ZUCCHINI, as listed in table 8-1. Because, in most cases, many of the same project personnel performed both pre- and postshot activities, estimates reflect the maximum number of DOD participants that would have been involved in one aspect of the project. If 15 persons performed preshot activities and five performed postshot recovery, the estimate listed in the table would be 15.

Project 1.14b, Measurements of Air-blast Phenomena with Self-recording Gauges, was designed to measure air-pressure variations produced by a nuclear detonation. Self-recording pressure gauges and pressure-time instruments were placed along a line extending north-northeast of the shot-tower from 180 to 1,350 meters. Preshot surveying, construction of instrumentation mounts, installation, and checking of gauges probably took two

Table 8-1: TEST GROUP PROJECTS WITH DEPARTMENT OF DEFENSE PARTICIPATION, SHOT ZUCCHINI

Project	Title	Participants	Estimated DOD Personnel
Military Effects Group			
1.14b	Measurements of Air-blast Phenomena with Self-recording Gauges	Ballistic Research Laboratories	2
2.8a	Contact Radiation Hazards Associated with Contaminated Aircraft	Air Force Special Weapons Center	5
2.8b	Manned Penetration of Atomic Clouds	Air Force Special Weapons Center	4
6.4	Test of IBDA Equipment	Wright Air Development Center	16
6.5	Test of Airborne Naval Radars for IBDA	Bureau of Aeronautics	*
9.4	Atomic Cloud Growth Studies	Air Force Cambridge Research Center; U.S. Weather Bureau; EG and G	*
Los Alamos Scientific Laboratory Test Group			
11.2	Radiochemistry Sampling	4926th Test Squadron (Sampling), AFSWC	15
18.3	Time Interval Measurements	Naval Research Laboratory	*

* Unknown

weeks. Postshot recovery of data was probably accomplished on shot-day at the farthest station, where radiation intensities were negligible, by two personnel in four hours. Recovery of the data from the remaining stations closer to ground zero was probably accomplished in two days by three personnel (89; 132).

The objective of Project 2.8a, Contact Radiation Hazard Associated with Contaminated Aircraft, was to assess the hazard presented by ground crew contact with an aircraft which had flown through a nuclear cloud. Approximately five ground personnel held several different types of gamma radiation survey meters near the contaminated components of the T-33 aircraft used in Project 2.8b. Manned Penetrations of Atomic Clouds, to determine radiation intensities. Radiation-decay studies were conducted up to 24 hours after the detonation. The general procedures followed in conducting this project are described in the TEAPOT Series volume. Available documents do not provide information about the project specific to the ZUCCHINI event (26; 89).

Project 2.8b, Manned Penetration of Atomic Clouds, was conducted to measure the radiation dosage and dose rate received by Air Force personnel and aircraft flying near and into the nuclear cloud. Specific information was sought by the Air Force on radiation dose rates inside the cloud, the total dose received during passage through the cloud, and the dose received on the return flight. Two T-33 aircraft instrumented with automatic recording dose-rate meters, radiac meters, and film packets penetrated the cloud a number of times to record radiation levels. The general procedures followed during this project are described in the TEAPOT Series volume. Available documents do not provide information specific to the ZUCCHINI event (13; 35; 89; 131).

Project 6.4, Test of IBDA Equipment, was designed to gather engineering evaluation data for an Indirect Bomb Damage

Assessment (IBDA) system installed in a B-50D aircraft. The second objetive was to determine the maximum operating range of the yield-measuring component of the system. The B-50D IBDA system consisted of the standard radar set, AN/APQ-24; a developmental radar set, AN/APA-106 (XA-1); a light and time recording set, AN/ASH-4 (XA-1); and a K-17 aerial camera. To accomplish the second objective, two F-94 aircraft were each instrumented with one ASH-4 recording set and one A-4 bomb-spotting camera.

The B-50D, staging out of Kirtland AFB, usually had a crew of ten. Since engineering evaluation tests were being conducted, one additional engineer and one technician accompanied the crew to monitor and ensure the operation of the IBDA system. The F-94s staged out of Indian Springs AFB with a crew of two each. The B-50D, which was positioned by radar navigation, simulated an aircraft delivering a nuclear bomb. At shot-time, the B-50D was located from six to 13 kilometers from ground zero. The F-94s were positioned by the Air Operations Center about 60 to 280 kilometers from ground zero. At least one crew member of each aircraft wore a film badge (28; 35; 89).

Project 6.5, Test of Airborne Naval Radars for IBDA, evaluated the suitability of using radar to determine the location, height of burst, and yield of a nuclear detonation. Project 6.5 tested standard Navy radars, unlike Project 6.4, which tested developmental radars. Supervised by the Navy Bureau of Aeronautics, Project 6.5 involved two AJ and one R-4D Navy aircraft. The aircraft flew in parallel patterns at altitudes of about 30,000 feet on a 90-degree heading inbound. At the time of detonation, they were located 11 kilometers west of ground zero. The aircraft maintained the inbound heading until 30 seconds after the arrival of the blast front. The aircraft then returned to their staging base in San Diego (35; 89; 130).

Project 9.4, Atomic Cloud Growth Study, required project personnel to take theodolite measurements on the rate of cloud rise and maximum cloud height. The theodolite was located at the north fence of Control Point Building 1 (33; 35; 48; 89).

8.1.2 Department of Defense Participation in LASL Test Group Projects

Although the LASL Test Group performed 14 projects at Shot ZUCCHINI, only two of these projects included DOD participation, as shown in table 8-1. Project 11.2, Radiochemistry Sampling, was performed by sampling pilots of the AFSWC 4926th Test Squadron (Sampling). The activities of the project are discussed in section 8.1.4 of this chapter. Project 18.3, Time Interval Measurements, was conducted for LASL by the Naval Research Laboratory (14). Little is known about the activities associated with Program 18 in general, or Project 18.3 in particular.

8.1.3 Department of Defense Operational Training Projects

The Air Force conducted five operational training projects at Shot ZUCCHINI and the Navy conducted one. These projects were designed to test service tactics and equipment and to train military personnel in the effects of nuclear detonations.

Project 40.1, Evaluation of IBDA Equipment and Techniques was carried out by three Strategic Air Command (SAC) B-47 aircraft operating from Davis-Monthan AFB. The objective was to train SAC crews in the tactics to be used during a nuclear detonation. The three aircraft flew over the NTS three minutes before the detonation. Two of the B-47s made passes over ground zero at altitudes ranging from 34,500 feet to 39,000 feet. The third B-47 flew directly over ground zero at 40,000 feet, leaving the NTS three minutes after the detonation (3; 35; 105).

Project 40.3, Crew Indoctrination, was designed to train Tactical Air Command aircrews in the effects of a nuclear detonation while flying simulated weapons-delivery and flyby maneuvers. Four F-9F aircraft, staging from George AFB, performed a flyby maneuver for this project. The planes established their positions by orbiting 110 to 130 kilometers northeast of the shot-tower. Two minutes before detonation, the aircraft ascended to altitudes ranging from 26,000 to 19,000 feet, and flew toward the shot area. Within eight kilometers of ground zero, the planes swung to the north until arrival of the blast wave. After blast arrival, the four aircraft returned to their staging base (3; 35; 105; 122).

Project 40.6, Calibration of Electromagnetic Effects, was conducted by Air Force personnel to expand existing information on the characteristics of the electromagnetic pulse emitted by a nuclear detonation. At 0900 hours on the day before the detonation, two men in a helicopter left station 40.6b on Yucca Lake, 16 kilometers from ground zero, to service eight sets of recording equipment, which were located on a circular perimeter around the shot-tower at distances between 10 and 20 kilometers. This activity required about six hours to complete. Two hours before the detonation, four men in two vehicles arrived at station 40.6b. After recovery operations began, these men retrieved data from their recording equipment and returned to Camp Mercury to analyze project results (89; 105; 106).

Project 40.8, Calibration of Bomb Debris, which was also conducted by Air Force personnel, was to determine the relative yields of nuclear products and residues for use in characterizing nuclear weapons. Project participation was integrated with the AFSWC sampling missions sponsored by LASL Project 11.2, and is discussed in the following section of this chapter (3; 35).

Project 40.10, Delivery Crew Indoctrination, was sponsored and conducted by the Navy. Its objective was to familiarize crewmen with the effects of a nuclear detonation on Navy aircraft. Six AD aircraft and seven F2H aircraft performed weapons-delivery maneuvers at altitudes ranging from 24,000 to 34,000 feet. The aircraft established a holding pattern over Indian Springs AFB and passed over ground zero 30 seconds before detonation. The aircraft then turned sharply to the right to receive the blast wave tail-on, after which they returned to their base at San Diego, California (3; 35; 105).

Project 40.24, Crew Indoctrination, was sponsored by the Air Force Air Research and Development Command. This project consisted of a flyby maneuver by two F-100 aircraft at altitudes of 50,000 feet. These aircraft passed over ground zero at the time of detonation. On completion of this pass, the aircraft returned to their staging base (3; 35;105).

8.1.4 Air Force Special Weapons Center Activities

AFSWC exercised operational control of all aircraft participating in the TEAPOT Series through its Air Operations Center. In addition, AFSWC personnel conducted cloud-sampling missions, courier service, cloud-tracking missions, and aerial surveys of terrain (35; 38).

Cloud sampling, which was conducted for LASL Project 11.2 and Air Force Project 40.8, enabled AEC and DOD scientists to obtain and analyze samples of the nuclear cloud. AFSWC courier services involved the delivery of the samples to the nuclear weapons design laboratories and military research and development laboratories. Cloud tracking not only allowed the Test Manager to plot the course of the nuclear cloud, but also helped the Civil Aviation Administration divert commercial aircraft from the cloud path. Terrain surveying allowed the Test Manager to monitor the test areas exposed to fallout.

Listed below are the types and numbers of aircraft, and the estimated numbers of AFSWC aircrews involved in air missions at Shot ZUCCHINI. With the exception of the B-50 cloud-tracking aircraft, which staged out of Kirtland AFB, AFSWC aircraft originated at Indian Springs AFB (35; 38).

PROJECT	TITLE	TYPE OF AIRCRAFT	NUMBER OF AIRCRAFT	NUMBER OF PERSONNEL
11.2/ 40.8	Sampling			
	Sampler Control	B-50	1	9
	Sampler	F-84G	6	6
	Courier Service	*	4	*
	Cloud Tracking	B-50	2	24
		B-25	1	5
	Aerial Surveys of Terrain	C-47	1	3
		H-19	2	10

*Unknown

Cloud Sampling

In connection with LASL Project 11.2, Radiochemistry Sampling, and Air Force Project 40.8, Calibration of Bomb Debris, six F-84G aircraft performed cloud sampling, with one B-50 serving as sampler control. One sampler aircraft, aborting before takeoff because of radio failure, was replaced by a spare aircraft. The F-84G aircraft collected samples at altitudes between 27,500 and 34,500 feet. The first sampler began cloud penetration two hours after the detonation. The B-50 probably had a crew of nine, and the F-84Gs had one pilot each. The following listing summarizes information on the six sampling missions (35; 38).

AIRCRAFT	NUMBER OF PENETRATIONS	TOTAL TIME IN CLOUD (minutes: seconds)	HIGHEST INTENSITY (R/h)
F-84G #038	3	1:40	30
F-84G #033	1	11:00	20
F-84G #043	1	2:50	40
F-84G #049	1	5:00	30
F-84G #037	1	5:00	15
F-84G #034	1	4:00	17

Courier Service

Four AFSWC aircraft provided courier service following Shot ZUCCHINI. Two aircraft left for Kirtland AFB seven hours after detonation to deliver samples for LASL. The next aircraft departed for McClellan AFB with samples for UCRL, and the last plane left for Bolling AFB with samples for the Air Force. Available documentation does not list the types of aircraft performing these courier services. However, if AFSWC followed the pattern established at previous shots, the aircraft were probably C-119s, C-47s, or B-25s (35; 38).

Cloud Tracking

Cloud tracking at Shot ZUCCHINI was divided into two parts. Two B-50s from Kirtland AFB, flying at 28,000 and 23,000 feet, respectively, tracked the nuclear cloud northeastward until they reached Minersville, Utah. Tracking time for the B-50s, which probably each had a crew of 12, was three hours and 50 minutes. A B-25 from Indian Springs AFB followed the cloud to a point southeast of Lake Mead (35; 38).

Aerial Surveys of Terrain

The terrain-survey mission was performed by two H-19 helicopters flying 300 to 500 feet above ground. Each helicopter probably carried a pilot, a co-pilot, and a radiological safety monitor. Terrain surveying was also conducted by a C-47 aircraft, which had three crewmen. The survey began at 1000 hours, five hours after detonation (35; 38).

8.2 RADIATION PROTECTION AT SHOT ZUCCHINI

The purpose of the various radiation protection procedures developed for Operation TEAPOT was to ensure that personnel exposure to ionizing radiation was as low as possible, while allowing participants to accomplish their tasks. Some of the procedures described in the Series volume resulted in records which enabled Exercise Desert Rock, the Joint Test Organization (JTO), and AFSWC to evaluate the effectiveness of their procedures. For Shot ZUCCHINI, such records including film-badge data have been located only for the JTO. The JTO Onsite Radiological Safety Organization was managed by AFSWP and staffed by the Army 1st Radiological Safety Support Unit, from Ft. McClellan, Alabama. The following descriptions detail the radiation protection activities at Shot ZUCCHINI, including dosimetry, use of radiological safety equipment, survey methods, isointensity plots, and decontamination records. Other than the Final Dosage Report, no record of Exercise Desert Rock VI or AFSWC radiological safety activities was located.

Dosimetry

From 10 through 16 May 1955, the period including Shot ZUCCHINI on 15 May, 222 film badges and 167 pocket dosimeters were issued. Film badge readings indicate that 16 personnel accumulated gamma radiation exposures greater than 2.0 roentgens but less than the JTO-authorized limit of 3.9 roentgens. No

participant exceeded the established 3.9 roentgen limit during Shot ZUCCHINI (19).

Six AFSWC pilots flew six F-84G aircraft for cloud sampling during Shot ZUCCHINI. Film-badge readings for these individuals ranged from 0.6 to 0.9 roentgens of gamma-radiation for the ZUCCHINI sampling mission. Film-badge data are also available for two officers involved in Project 2.8, who received exposures of 3.3 and 3.6 roentgens of gamma-radiation (26; 35).

Logistical Data for Radiological Safety Equipment

The General Supply Division of the Logistics Section issued 686 pieces of protective clothing and 160 respirators during the period including Shot ZUCCHINI. In addition, the Instrument Repair Section issued 218 radiation survey meters during the test period (19).

Monitoring Activities

On shot-day at 0502 hours, two minutes after detonation, the initial survey party, checkpoint teams, and north patrol left the Control Point at Yucca Pass to proceed to their assembly area. The road patrols found Mercury Highway free of contamination. The initial survey was routine and was completed at 0617 hours. A copy of the initial isointensity map is shown in figure 8-1. Helicopters were not used for the initial survey, although they were used for resurveys. Checkpoints were established at 0515 hours, and signs were posted on the main access roads by 0830 hours. The area was resurveyed on 16 May. A copy of the isointensity map generated from this resurvey is shown in figure 8-2. Average exposures for the initial survey and first resurvey teams were 0.6i and 0.37 roentgens, respectively. In addition to the ground survey, two H-19 helicopters were used to perform radiation surveys of the shot area after the shot. Each H-19 had a crew of five.

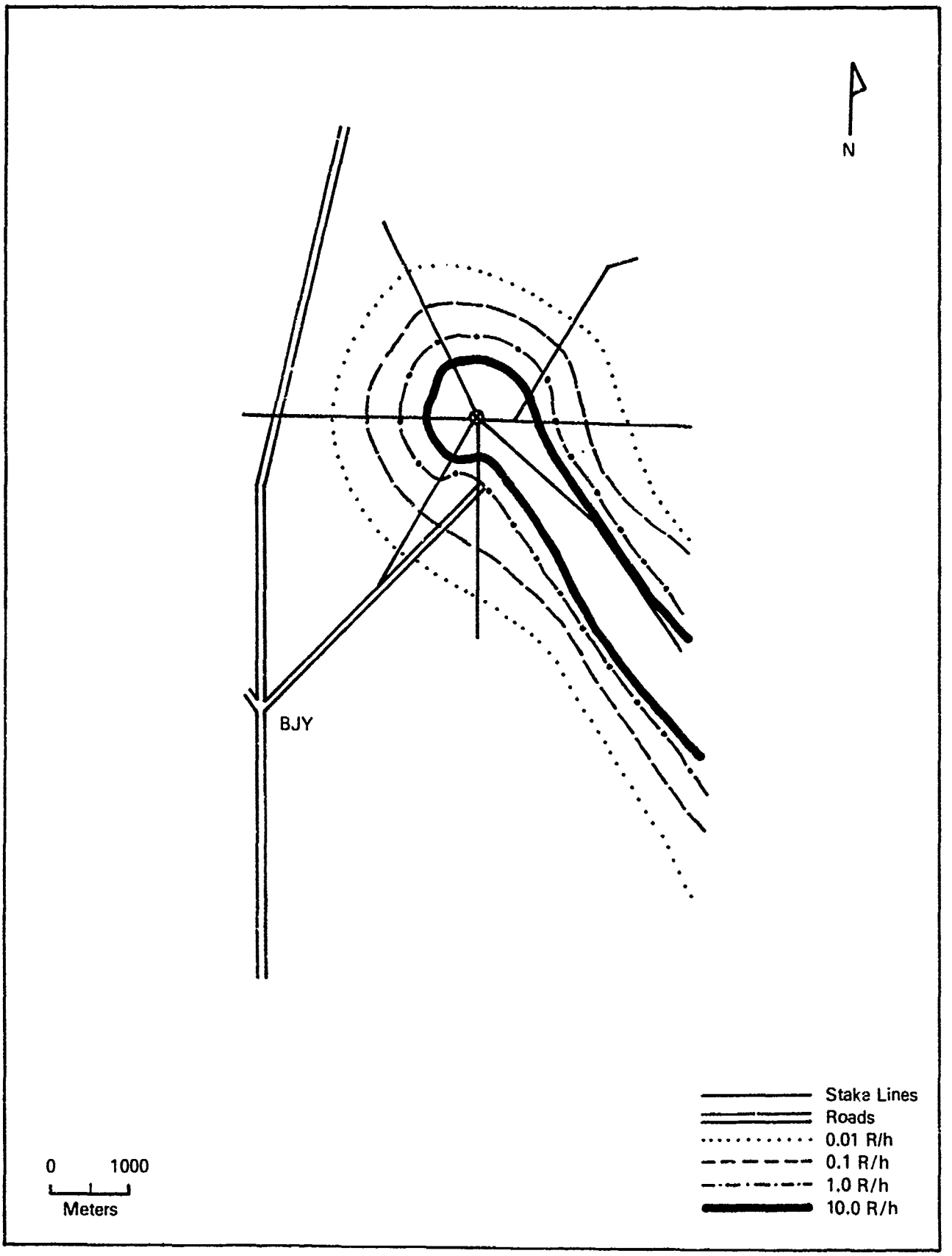


Figure 8-1: INITIAL SURVEY FOR SHOT ZUCCHINI, 15 MAY 1955, 0528 TO 0617 HOURS

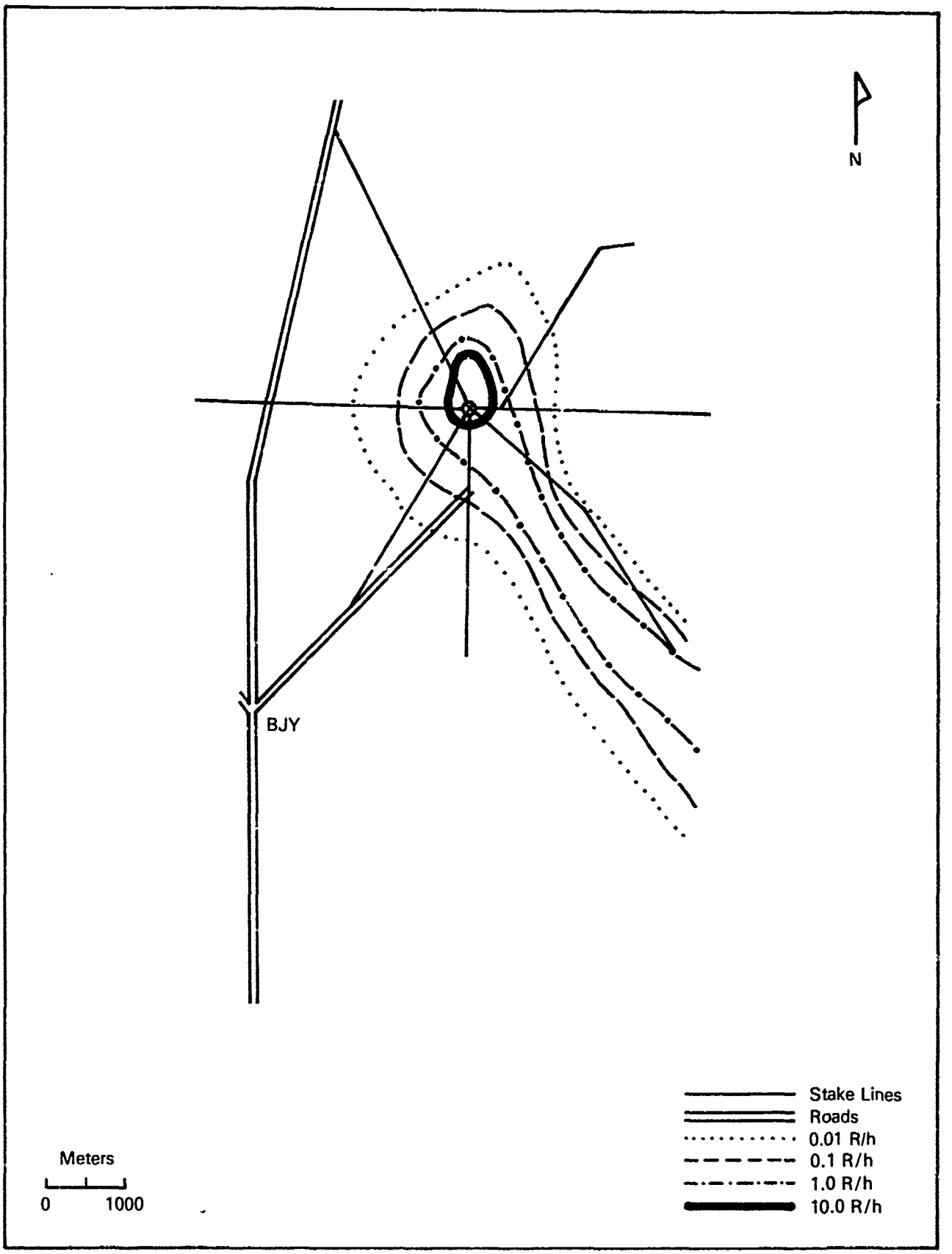


Figure 8-2: RESURVEY FOR SHOT ZUCCHINI, 16 MAY 1955, 0832 TO 0922 HOURS

In addition to its survey work, the Monitoring Section provided monitors for the following projects (19):

PROJECT	NUMBER
16.1	1
13.3	1

In addition, one monitor each was provided to security, REECo, and the Director of Weapons Effects Tests. From 10 to 16 May, two monitors were furnished for REECo, and one monitor was furnished for Project 34.3 (19).

Plotting and Briefing

The Test Manager declared recovery hour at 0625 hours, and recovery parties began their operations. Before recovery hour, Project 15.3 personnel were released because it was evident that their recovery area was well outside radiation areas. Fallout was fairly heavy to the southeast, with the 10 R/h area extending beyond accessible terrain.

On shot-day, the Plotting and Briefing Section cleared ten parties for access into the shot area. The next day, seven parties received briefings for access into the test area (19; 75).

Decontamination

During the period covering Shot ZUCCHINI, 10 to 16 May, members of the Vehicle and Equipment Decontamination Section decontaminated one truck (19).

SHOTS ESS THROUGH MET AND ZUCCHINI
REFERENCE LIST

The following list of references represents only those documents cited in the ESS through MET and ZUCCHINI volume. When a DASA-WT document is followed by an EX, the latest version has been cited. A complete list of documents reviewed during the preparation of the TEAPOT Series volumes is contained in the Operation TEAPOT volume.

AVAILABILITY INFORMATION

An availability statement has been included at the end of the reference citation for those readers who wish to read or obtain copies of source documents. Availability statements were correct at the time the bibliography was prepared. It is anticipated that many of the documents marked unavailable may become available during the declassification review process. The Coordination and Information Center (CIC) and the National Technical Information Service (NTIS) will be provided future DNA-WT documents bearing an EX after the report number.

Source documents bearing an availability statement of CIC may be reviewed at the following address:

Department of Energy
Coordination and Information Center
(Operated by Reynolds Electrical & Engineering Co., Inc.)
ATTN: Mr. Richard V. Nutley
2753 S. Highland
P.O. Box 14100 Phone: (702) 734-3194
Las Vegas, Nevada 89114 FTS: 598-3194

Source documents bearing an availability statement of NTIS may be purchased from the National Technical Information Service. When ordering by mail or phone, please include both the price code and the NTIS number. The price code appears in parentheses before the NTIS order number.

National Technical Information Service
5285 Port Royal Road Phone: (703) 487-4650
Springfield, Virginia 22161 (Sales Office)

Additional ordering information or assistance may be obtained by writing to the NTIS, Attention: Customer Service, or by calling (703) 487-4660.

REFERENCE LIST
SHOTS ESS TO MET AND ZUCCHINI

1. Air Force Special Weapons Center, Field Test Group #5 (Prov). "Operation Plan 1-54 for Operation TEAPOT." Kirtland AFB, NM.: AFSWC. 12/20/54. 200 Pages.***

2. Allgood, J.; Shaw, W. "Test of Concrete Panels." Albuquerque, NM.: Field Command, AFSWP. WT-1130. 02/00/57. 82 Pages. (A05) AD 224 422.*

3. Armed Forces Special Weapons Project, Field Command WET. [Reports File. Subject: Operational Training Status Report; Monthly Status Reports.] Albuquerque, NM.: Field Command, AFSWP. 00/00/54. 50 Pages.**

4. Army Engineer School. "Full Scale Test Atomic Demolition Munition, Project 40.16, Operation TEAPOT." Fort Belvoir, VA.: Army Engineer School. 06/00/55. 24 Pages.***

5. Atomic Energy Commission. "Military Operational Training." Washington, DC.: Atomic Energy Commission. Undated. 98 Pages. (Box 548 in National Archives.)

6. Banister, J.; Shelton, F. "Special Measurements of Dynamic Pressure versus Time and Distance, Project 1.11." Albuquerque, NM.: Field Command, AFSWP. WT-1110. 02/28/58. 70 Pages. (A04) AD 617 155.*

7. Bridgman, L., Ed. Jane's All the World's Aircraft, 1955-1956. New York.: McGraw-Hill. 00/00/55.

8. Bridgman, L., Ed. Jane's All the World's Aircraft, 1956-1957. New York.: McGraw-Hill. 00/00/56.

9. Bryant, E.; Ethridge, N.; Johnson, M. Response of Drag Type Equipment Targets in the Precursor Zone, Project 3.1. Albuquerque, NM.: Field Command, DASA. WT-1123. 10/28/59. 132 Pages. (A07) AD 339 948.*

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

10. Burden, H. Transient Drag Characteristics of a Spherical Model, Project 1.14a. Albuquerque, NM.: Field Command, DASA. WT-1114. 10/23/59. 96 Pages. (A05) AD 617 152.*

11. Civil Effects Test Group. "Locations for Field Exercise Activity, Open Shot (ZUCCHINI)." CETG, FCDA. 03/15/55. 6 Pages.**

12. Clark, J. C. Annex D: Radiological Safety Plan, Test Director's Operation Order 1-55. Los Alamos, NM.: LASL. 02/03/55. 3 Pages.****

13. Clark, J. C., Test Director. [Memoranda Authorizing Overexposure of Project 2.8 Personnel.] Mercury, NV. 04/00/55. 2 Pages.***

14. Clark, J. C. Report of the Test Director, Operation TEAPOT. Los Alamos, NM.: LASL. LA-1966. 10/00/55. 254 Pages.***

15. Cohen, A.; Jachter, M.; Murphy, H. "Evaluation of Military Radiac Equipment, Project 6.1.1a." Albuquerque, NM.: Field Command, AFSWP. WT-1137. 02/28/58. 60 Pages. (A04) AD 460 281.*

16. Collison, T. D., LTC, USA. [Addenda to Final Dosage Report.] Mercury, NV.: Atomic Energy Commission. 05/24/55. 21 Pages.****

17. Collison, T. D., LTC, USA. [Memoranda Describing Overexposure of Personnel.] Mercury, NV.: Atomic Energy Commission. 00/00/55, 23 Pages.****

18. Collison, T. D., LTC, USA. Memoranda for the Test Director, Subject: Overexposure of Project Personnel, 7 March - 6 April 1955. [Mercury, NV.]. 00/00/55. 12 Pages.****

19. Collison, T. D., LTC, USA. Radiological Safety. Albuquerque, NM.: Field Command, AFSWP. WT-1166. 05/00/55. 184 Pages. (A09) AD 465 424.*

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

20. Corsbie, R. L., Director, Civil Effects Test Group. Memorandum for J. C. Clark, Subject: CETG Summary Reports for Shots APPLE and WASP PRIME--D+1, 1200 Hours; wo/encl. Nevada Test Site, NV. 02/03/55. 6 Pages.**

21. Corsbie, R. L., Director, Civil Effects Test Group. Memorandum for J. C. Clark, Subject: CETG Summary Report for Shot ESS--D+1, 1200 Hours. Nevada Test Site, NV. 03/24/55. 2 Pages.**

22. Corsbie, R. L., Director, Civil Effects Test Group. Memorandum for J. C. Clark, Subject: CETG Summary Report for Shot HA--D+1, 1200 Hours. Nevada Test Site, NV. 04/07/55. 1 Page.**

23. Corsbie, R. L., Director, Civil Effects Test Group. Memorandum for J. C. Clark, Subject: CETG Summary Reports for Shot MET--D+1, 1200 Hours. Nevada Test Site, NV. 04/16/55. 2 Pages.**

24. Corsbie, R. L., Director, Civil Effects Test Group. Memorandum for J. C. Clark, Subject: CETG Summary Report for Shot POST--D+1, 1200 Hours. Nevada Test Site, NV. 04/11/55. 2 Pages.**

25. Corsbie, R. L., Director, Civil Effects Test Group. Memorandum for J. C. Clark, Subject: CETG Summary Reports for Shot ZUCCHINI--D+1, 1200 Hours; w/encl. Nevada Test Site, NV. 05/17/55. 2 Pages.**

26. Crumley, P.; Dick, J.; Kaericher, K. "Contact Radiation Hazard Associated with Contaminated Aircraft, Project 2.8a." Albuquerque, NM.: Field Command, AFSWP. WT-1122. 10/00/57. 34 Pages. (A03) AD 617 153.*

27. Day, R.; Guthrie, A. "Thermal Measurements from Aircraft in Flight, Project 8.4a." Albuquerque, NM.: Field Command, AFSWP. WT-1145. 01/00/58. 34 Pages. (A03) AD 339 907.*

28. Deegan, T., Capt., USAF; Nickel, W., 1/Lt., USAF. "Test of IRDA Equipment, Project 6.4." Albuquerque, NM.: Field Command, AFSWP. WT-1141. 05/00/57. 39 Pages. (A03) AD 341 061.*

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

29. Defense Atomic Support Agency. Technical Summary of Military Effects, Programs, 1-9. Albuquerque, NM.: Field Command, DASA. WT-1153. 02/23/60. 235 Pages.***

30. Department of Energy, Office of Public Affairs; Los Alamos Scientific Laboratory; Lawrence Livermore Laboratory; Sandia Laboratories. "Announced United States Nuclear Tests, July 1945 through 1979." [Mercury, NV.]: Nevada Operations Office. NVO-209. 01/00/80. 38 Pages.**

31. Department of the Navy, Bureau of Ships. Passive Defense Operation Training; Project [40.9] Directory. Washington, D.C. 03/10/55. 25 Pages. 800-55-0-200.***

32. Dohrenwend, C.; Mills, L.; Kinney, J.; et al. Flexible Measuring Devices and Inspection of Operation JANGLE Structures, Project 3.3.1. Albuquerque, NM.: Field Command, AFSWP. WT-1125. 07/28/58. 124 Pages. (A06) AD 617 172.*

33. Edgerton, Germeshausen, and Grier, Inc. "Technical Photography. Project 9.1." Albuquerque, NM.: Field Command, AFSWP. WT-1151. 08/12/57. 18 Pages. (A02) AD 617 171.*

34. DELETED

35. Fackler, P. H., Col., USAF. Technical Air Operations. Kirtland AFB, NM.: AFSWC. WT-1206-EX. 09/01/80. 278 Pages. (A13) AD/A995 106.*/**

36. Fackler, P. H. "Interview with Colonel Paul Fackler, USAF (Retired)." 04/24/80.***

37. Fackler, P. H. [Telephone Conversation with Col. Paul Fackler, USAF (Ret.)] 08/21/80. 2 Pages.***

38. Fackler, P. H. [Taped Interview with Col. Paul H. Fackler, USAF (Ret.), Former Air Operations Officer, 4925th Test Group, Subject: CONUS Tests.] McLean, VA. 04/22/81.***

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

39. Field Command, Armed Forces Special Weapons Project. Memorandum to Distribution, Subject: Master Station Locator for ESS Shot, Operation TEAPOT. Albuquerque, NM. FCWET 54-2295-2. 12/20/54. 2 Pages.**

40. Field Command, Armed Forces Special Weapons Project, DWET. 1st Indorsement, Subject: Overexposure of Drop Aircrew on HA Shot. Sandia Base, NM. 11/08/54. 1 Page.

41. General Electric Company--TEMPO. Compilation of Local Fallout Data from Test Detonations 1945-1962. Vol. I: "Continental U.S. Tests." Washington, D.C.: Defense Nuclear Agency. DNA 1251-1-EX. 00/00/79. 619 Pages. (A99) AD/A079 309.*

42. Gerster, M. The Special Weapons Center and Atomic Testing. Kirtland AFB, NM.: AFSWC. K242.01-K242.04. 01/00/57. 305 Pages.***

43. Goetz, J.; Kaul, D.; Klemm, J.; et al. Analysis of Radiation Exposure for Troop Observers Exercise Desert Rock VI, Operation TEAPOT. Washington, D.C.: Defense Nuclear Agency. DNA-5354F. 07/15/80. 86 Pages.**

44. Gordon, M.; Stoudt, J.; Francis, A. "Dust Density versus Time and Distance in the Shock Wave, Project 1.13." Albuquerque, NM.: Field Command, AFSWP. WT-1113. 06/21/57. 52 Pages. (A03) AD/B951 675.*

45. Graham, J. "Gamma Dose Rate versus Time and Distance, Project 2.4." Albuquerque, NM.: Field Command, DASA. WT-1118-EX. 01/10/81. 59 Pages. (A04) AD/A995 096.*/**

46. Graham, J. B.; Larrick, R. J.; Johnson, O. E. "Gamma Exposure versus Distance, Project 2.1." Albuquerque, NM.: Field Command, DASA. WT-1115. 0/01/81. 46 Pages. (A03) AD/A995 087.*/**

47. Graham, J., CPT, USA; Biggerstaff, J. "Project Radiation Effects on Selected Components and Materials, Project 6.2." Albuquerque, NM.: Field Command, AFSWP. WT-1139. 08/00/57. 21 Pages. (A02) AD 617 176.*

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

48. Grossman, B.; Machta, L.; Quenneville, L. R. Atomic Cloud Growth Study, Project 9.4. Albuquerque, NM.: Field Command, AFSWP. WT-1152. 10/00/55. 136 Pages. (A07) AD 426 840.*

49. Hanscome, T.; Willet, D. "Neutron Flux Measurements Operation TEAPOT, Project 2.2." Albuquerque, NM.: Field Command, AFSWP. WT-1116-EX. 01/01/81. 44 Pages. (A03) AD/A995 090.*/**

50. Harris, P. "Physical Measurement of Neutron and Gamma Radiation Dose from High Neutron Yield Weapons and Correlation, Project 39.7." Los Alamos, NM.: LASL. ITR-1167. 04/00/55. 106 Pages.***

51. Haskell, N.; Fava, J.; Burbaker, R. "Measurement of Free Air Atomic Blast Pressures, Project 1.1." Albuquerque, NM.: Field Command, AFSWP. WT-1101. 02/14/58. 52 Pages. (A04) AD 460 280.*

52. Headquarters, 4925th Test Group (Atomic). Letter to Commanding General, Field Command, AFSWP, Subject: Overexposure of Drop Aircrew on HA Shot. Kirtland AFB, NM. 11/08/54. 1 Page.****

53. Headquarters, 4925th Test Group (Atomic). Memorandum for Test Director, Subject: Effects Envelopes for High Altitude Shot of Operation TEAPOT. Kirtland AFB, NM. 12/14/54. 1 Page.

54. Headquarters, Exercise Desert Rock. Final Report of Operations of the Exercise Director, Exercise Desert Rock VI; A Troop Indoctrination and Orientation and Troop Test Program Involving Department of Defense Agencies. (Short Title: DESERT ROCK IV, Final Report.) Presidio of San Francisco, CA.: Sixth US Army. 00/00/55. 101 Pages.*

55. Headquarters, Exercise Desert Rock. Letter to CG, Sixth Army, Subject: Safety Plan for APPLE w/Annex A. Las Vegas, NV. AMCDR-S-3 354.51. 02/04/55. 3 Pages.**

56. Headquarters, Exercise Desert Rock. Letter to CG, Sixth Army, Subject: Safety Plan for ESS w/Annex A. Las Vegas, NV. 03/17/55. 3 Pages.**

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

57. Headquarters, Exercise Desert Rock. Operation Order Number 5, Desert Rock VI, APPLE I. Camp Desert Rock, NV.: HQS., Camp Desert Rock. 03/10/55. 40 Pages. (A03) AD/A080 228.*

58. Headquarters, Exercise Desert Rock. Operation Order Number 7, Desert Rock VI, ESS. Camp Desert Rock, NV.: HQS., Camp Desert Rock. 05/21/55. 10 Pages. (A02) AD/A080 233.*

59. Headquarters, Exercise Desert Rock. Operation Order Number 8, Desert Rock VI, MET. Camp Desert Rock, NV.: HQS., Camp Desert Rock. 04/06/55. 10 Pages. (A02) AD/A080 233.*

60. [Headquarters, Exercise Desert Rock]. Operational Schedule Full Scale Test--Atomic Demolition Munition Project 40.16 [Shot ESS]. [Las Vegas, NV.] 01/16/55. 7 Pages.

61. Headquarters, Sixth Army, Chemical Section. "CBR Defense Team Training, Project 40.19." Presidio of San Francisco: Sixth US Army. 10/00/55. 51 Pages. (A04) AD/A995 046.*

62. Hillendahl, R.; Laughridge, F. Basic Thermal-Radiation Measurements, Project 8.4b. Albuquerque, NM.: Field Command, DASA. WT-1146. 07/00/59. 96 Pages. (A05) AD 339 905.*

63. Hopton, R.; Plum, W. "Radiant Energy Delivered Prior to the First Minimum, Project 8.4c." Albuquerque, NM.: Field Command, AFSWP. WT-1147. 08/00/57. 16 Pages. (A02) AD 357 981.*

64. Hovey, W. "Thermoelastic Response of an Aluminum Box Beam, Project 5.5b." Albuquerque, NM.: Field Command, AFSWP. WT-1136. 05/00/58. 68 Pages. (A04) AD 341 059.*

65. Imrie, G.; Sharp, R. "Radiation Energy Absorbed by Human Phantoms in a Fission Fallout Field, Project 2.6." Albuquerque, NM.: Field Command, AFSWP. WT-1120. 00/00/55. 60 Pages. (A04) AD 244 421.*

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

66. Inn, E. C. Y. "Air Temperature Measurements over Several Surfaces, Project 8.4e." Albuquerque, NM.: Field Command, AFSWP. WT-1149. 09/03/57, 42 Pages. (A03) AD 611 255.*

67. Jenkins, R.; Hopton, R.; Plum, W. "Irradiance Measurements with High Time Resolution, Project 8.4f." Albuquerque, NM.: Field Command, AFSWP. WT-1150. 01/00/58. 26 Pages. (A03) AD 341 062.*

68. Johnson, R. . LTJG, USN; Cook, C.; Webb, L.; et al. "Neutron Induced Radioactive Isotopes in Soils, Project 2.3a." Albuquerque, NM.: Field Command, AFSWP. WT-1117. 08/00/58. 53 Pages. (A04) AD 617 180.*

69. Joint Office of Test Information. [General Press Releases.] Las Vegas, NV.: JOTI. 00/00/55. 23 Pages.**

70. Joint Office of Test Information. [Press Releases for Shots APPLE and WASP PRIME.] Las Vegas, NV.: JOTI. JOTI-55-77. 03/26/55. 8 Pages.**

71. Joint Office of Test Information. [Press Releases Regarding Shot HA.] Las Vegas, NV.: JOTI. JOTI-55-89. 04/07/55. 6 Pages.**

72. Joint Office of Test Information. [Press Releases Regarding Shot HADR.] Las Vegas, NV.: JOTI. JOTI-55-74. 03/25/55. 3 Pages.**

73. Joint Office of Test Information. [Press Releases Regarding Shot POST.] Las Vegas, NV.: JOTI. JOTI-55-90. 04/07/55. 2 Pages.**

74. Joint Office of Test Information. [Press Release for Shot ZUCCHINI.] Las Vegas, NV.: JOTI. 05/10/55. 1 Page.**

75. Joint Test Organization, Office of Test Director. [Subject: Access Lists by Project for Each Shot.] Mercury, NV. 00/00/55. 48 Pages.***

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

76. Joint Test Organization, Military Effects Group. Memorandum for Test Director, Subject: Operational Requirements for HA. Nevada Test Site, NV. FCNTS 55-741-0. 03/30/55. 3 Pages.**

77. Joint Test Organization, Military Effects Group. Memorandum for Test Director, Subject: Post Shot Report--APPLE. Nevada Test Site, NV. FCNTS 55-756-0. 03/31/55. 5 Pages.**

78. Joint Test Organization, Military Effects Group. Memorandum for Test Director, Subject: Post Shot Report--ESS. Nevada Test Site, NV. FCNTS 55-731-0. 03/29/55. 5 Pages.**

79. Joint Test Organization, Military Effects Group. Memorandum for Test Director, Subject: Post Shot Report--HA. Nevada Test Site, NV. FCNTS 55-844-0. 04/09/55. 5 Pages.**

80. Joint Test Organization, Military Effects Group. Memorandum for Test Director, Subject: Post Shot Report--MET. Nevada Test Site, NV. FCNTS 55-943-0. 04/19/55. 12 Pages.**

81. Joint Test Organization, Military Effects Group. Memorandum for Test Director, Subject: Post Shot Report--POST. Nevada Test Site, NV. FCNTS 55-877-0. 04/13/55. 3 Pages.**

82. Joint Test Organization, Military Effects Group. Memorandum for Test Director, Subject: Post Shot Report--WASP PRIME. Nevada Test Site, NV. FCNTS. 03/31/55. 2 Pages.**

83. Joint Test Organization, Office of Test Director. Operation Order No. 1-55 (TEAPOT); Annex G--Special Instructions, APPLE. Mercury, NV.: AEC, JTO. J3C-174. 03/08/55. 21 Pages.**

84. Joint Test Organization, Office of Test Director. Operation Order No. 1-55 (TEAPOT); Annex J--Special Instructions, HADR. Mercury, NV.: AEC, JTO. J3C-205. 03/24/55. 10 Pages.**

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

85. Joint Test Organization, Office of Test Director. Operation Order No. 1-55 (TEAPOT); Annex K--Special Instructions, MET. Mercury, NV.: AEC, JTO. J3C-215. 04/04/55. 23 Pages.**

86. Joint Test Organization, Office of Test Director. Operation Order No. 1-55 (TEAPOT); Annex L--Special Instructions, POST. Mercury, NV.: AEC, JTO. J3C-215. 04/04/55. 15 Pages.**

87. Joint Test Organization, Office of Test Director. Operation Order No. 1-55 (TEAPOT); Annex M--Special Instructions, HA. Mercury, NV.: AEC, JTO. J3C-210. 03/31/55.**

88. Joint Test Organization, Office of Test Director. Operation Order No. 1-55 (TEAPOT); Annex O--Special Instructions, ESS. Mercury, NV.: AEC, JTO. J3C-203. 03/22/55. 15 Pages.**

89. Joint Test Organization, Office of Test Director. Operation Order No. 1-55 (TEAPOT); Annex Q--Special Instructions, ZUCCHINI. Mercury, NV.: AEC, JTO. J3C-236. 04/26/55. 7 Pages.**

90. Joint Test Organization, Office of Test Director. Operation Order No. 1-55 (TEAPOT); Annex S--Special Instructions, WASP PRIME. Mercury, NV.: AEC, JTO. J3C-207. 03/25/55. 14 Pages.**

91. Kester, J.; Ferguson, R., Capt., USAF. Project 5.4 Evaluation of Fireball Lethality Using Basic Missile Structures. Albuquerque, NM.: Field Command, AFSWP. WT-1134. 04/00/58. 129 Pages. (A07) AD 340 137.*

92. Kornhauser, M.; Petes, J. Drag Force Measurements, Project 1.12. Albuquerque, NM.: Field Command, AFSWP. WT-1111. 06/13/58. 170 Pages. (A08) AD 610 481.*

93. Kviljord, A. "Measurement of Direct and Ground-reflected Thermal Radiation at Altitude, Project 8.1." Albuquerque, NM.: Field Command, AFSWP. WT-1143. 05/00/57. 51 Pages. (A04) AD 339 915.*

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

94. Lewis, J. Crater Measurements, Project 1.6. Albuquerque, NM.: Field Command, AFSWP. WT-1105. 07/18/58. 80 Pages. (A05) AD 491 309.*

95. Lindberg, R.; Romney, E.; Olafson, J.; et al. Factors Influencing the Biological Fate and Persistence of Radioactive Fallout, Project 37.1. Los Angeles, CA.: UCLA. WT-1177. 01/00/59. 78 Pages.

96. Lorrian, P.; Schwartz, E. "Structures Instrumentation, Project 3.10." Albuquerque, NM.: Field Command, AFSWP. WT-1107. 05/00/58. 32 Pages. (A03) AD 465 423.*

97. Los Alamos Scientific Laboratory, J-Division. Memorandum for J. C. Clark, Subject: WET54-503D [Concerning Statement Regarding Requested Overexposures for Project 2.6]. Los Alamos, NM. 09/27/54. 1 Page.

98. Lyon, B. [Contamination Warnings -- Missing Cannisters and Shot ESS Area.] Mercury, NV.: Atomic Energy Commission. 00/00/55. 3 Pages.***

99. Mather, R.; Johnson, R.; Tomnovec, F.; Cook, C. Gamma Radiation Field above Fallout Contaminated Ground, Project 2.3b. Albuquerque, NM.: Field Command, DASA. WT-1225. 10/28/59. 98 Pages. (A05) AD 460 282.*

100. McLoughlin, R. Preshock Sound Velocities near the Ground in the Vicinity of an Atomic Explosion, Project 1.5. Albuquerque, NM.: Field Command, AFSWP. WT-1104. 05/00/55. 76 Pages. (A05) AD 224 419.*

101. Miller, M.; Lisman, H.; Jacoby, D.; et al. Missile Detonation Locator, Project 6.3. Albuquerque, NM.: Field Command, AFSWP. WT-1140. 08/00/57. 114 Pages. (A06) AD 341 060.*

102. Montgomery, C. D. "Report on Tests of Combat Vehicles in Operation TEAPOT." Aberdeen, MD.: Ballistic Research Laboratories. 11/00/55. 12 Pages.

103. Moulton, J.; Walthall, E. Shockwave Photography, Project 1.2. Albuquerque, NM.: Field Command, AFSWP. WT-1102. 05/15/58. 116 Pages. (A06) AD 611 253.*

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

104. O'Brien, B. "Response of Small Petroleum Products Tanks, Project 3.9." Albuquerque, NM.: Field Command, AFSWP. WT-1131. 03/00/57. 26 Pages. (A03) AD 340 138.*

105. Parsons, H., Col., USAF. Operation TEAPOT, Operational Summary. Albuquerque, NM.: Field Command, AFSWP. WT-1158-EX. 10/01/79. 93 Pages. (A05) AD/B951 749.*/**

106. Parsons, H., Col., USAF. Operational Training Projects Manned Stations for TEAPOT. Albuquerque, NM.: AFSWP. 01/04/55. 2 Pages.**

107. Petriken, T. "Evaluation of a Radiological Defense Warning System (Project CLOUDBURST), Project 6.1.1b." Albuquerque, NM.: Field Command, AFSWP. WT-1112. 08/16/57. 16 Pages. (A02) AD 617 177.*

108. Plum, W.; Jenkins, R.; Hopton, R. "Irradiance Measurements with Time Resolution, Project 8.4f." Albuquerque, NM.: Field Command, AFSWP. WT-1229. 02/27/59. 16 Pages. (A02) AD/A995 010.*

109. Plum, W.; Parker, W. "Spectrometer Measurements, Project 8.4d." Albuquerque, NM.: Field Command, AFSWP. WT-1148. 01/00/58. 26 Pages. (A03) AD 617 178.*

110. Portsmouth Naval Shipyard. "Passive Defensive Operations Training: Report of Training Experience." [Project 40.9.] Portsmouth, VA.: Portsmouth Naval Shipyard. 04/18/55. 4 Pages.**

111. Purkey, G.; Lounsbery, W., Capt., USAF. Destructive Loads on Aircraft in Flight, Project 5.1. Albuquerque, NM.: Field Command, AFSWP. WT-1132. 01/00/58. 92 Pages. (A05) AD 357 980.*

112. Purkey, G.; Mitchell, R., Lt., USAF. Structural Response of F-84 Aircraft in Flight, Project 5.2. Albuquerque, NM.: Field Command, AFSWP. WT-1133. 07/00/58. 97 Pages. (A05) AD 362 111.*

113. Reed, J.; Banister, J.; Beyeler, J,; et al. "Material Velocity Measurements of High Altitude Shot, Project 1.9." Albuquerque, NM.: Field Command, AFSWP. WT-1108. 06/00/56. 26 Pages. (A03) AD 611 321.*

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

114. Reed, J.; Banister, J.; Shelton, F. "Ground Level Microbarographic Pressure Measurements from a High Altitude Shot, Project 1.3." Albuquerque, NM.: Field Command, AFSWP. WT-1103. 05/00/55. 36 Pages. (A03) AD 611 254.*

115. Sachs, D.; Swift, L. Underground Explosion Effects, Project 1.7. Albuquerque, NM.: Field Command, AFSWP. WT-1106. 03/03/58. 120 Pages. (A06) AD 617 181.*

116. Sachs, D.; Swift, L.; Sauer, F. Airblast Overpressure and Dynamic Pressure over Various Surfaces, Project 1.10. Albuquerque, NM.: Field Command, AFSWP. WT-1109. 09/09/57. 194 Pages. (A09) AD 617 182.*

117. Schmidt, L. Study of Drag Loading of Structures in the Precursor Zone, Project 3.2. Albuquerque, NM.: Field Command, AFSWP. WT-1124. 01/30/59. 174 Pages. (A08) AD 617 149.*

118. Schmuchyk, M.; Bouton, E. Fallout Studies, Project 2.5.1. Albuquerque, NM.: AFSWP. WT-1119. 07/23/58. 133 Pages. (A07) AD 449 680.*

119. Sinnamon, G.; Haltiwanger, J.; Matsuda, F.; et al. Effect of Positive Phase Length of Blast on Drag and Semidrag in Industrial Buildings Part 1, Project 3.7. Albuquerque, NM.: Field Command, AFSWP. WT-1129. 12/00/58. 122 Pages. (A06) AD 617 174.*

120. Sinnamon, G.; Woodring, R.; Newmark, N.; et al. "Behavior of Underground Structures Subjected to an Underground Explosion, Project 3.3.2." Albuquerque, NM.: Field Command, AFSWP. WT-1126. 10/11/57. 54 Pages. (A03) AD 617 150.*

121. Stetson, R.; Shirasawa, T.; Sandomire, M.; et al. Distribution and Intensity of Fallout from the Underground Shot, Project 2.5.2. Albuquerque, NM.: Field Command, AFSWP. WT-1154. 03/14/58. 92 Pages. (A05) AD 617 179.*

122. Stickle, G.; Brake, N. "TAC Participation in TEAPOT." Langley AFB, VA.: USAF, TAC. OA Memo No. 88. 12/17/54. 50 Pages.**

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

123. Taplin, G.; MacDonald, N.; McFarland, ..; et al. Measurement of Initial and Residual Radiations by Chemical Methods, Project 39.6. Oak Ridge, TN.: AEC, TIS. ITR-1171. 05/00/55. 76 Pages. (A05) AD/A995 064.*

124. Vaile, R.; Mills, L., LTJG., USN. "Evaluation of Earth Cover as Protection to above Ground Structures, Project 3.6." Albuquerque, NM.: Field Command, AFSWP. WT-1128. 12/00/56. 66 Pages. (A04) AD 617 173.*

125. Vortman, L. "Effects of an Atomic Explosion on Group and Family Type Shelters, Projects 34.1 and 34.3." Battle Creek, MI.: FCDA. WT-1161. 12/00/55. 192 Pages.

126. White, C.; Chiffelle, T.; Richmond, D.; et al. Biological Effects of Pressure Phenomena Occurring inside Protective Shelters Following a Nuclear Detonation, Project 33.1. Albuquerque, NM.: Lovelace Foundation. WT-1179. 10/00/56. 219 Pages. (A10) AD 611 319.*

127. Whitford, D. Effects of Nuclear Explosions on Fighter Aircraft Components, Project 5.5a. Albuquerque, NM.: Field Command, AFSWP. WT-1135. 02/00/58. 94 Pages. (A05) AD 362 112.*

128. Woodring, R.; Sinnamon, G.; Newmark, N. Air Blast Effects on Underground Structures, Project 3.4. Albuquerque, NM.: Field Command, AFSWP. WT-1127. 08/20/57. 84 Pages. (A05) AD 617 175.*

129. Work, G. A. "Accuracy of Military Radiacs, Project 6.1.2." Albuquerque, NM.: AFSWP. WT-1138. 11/15/57. 56 Pages. (A04) AD 420 801.*

130. Zirkind, R. "Test of Airborne Naval Radars for IBDA, Project 6.5." Albuquerque, NM.: Field Command, AFSWP. WT-1142. 08/00/57. 15 Pages. (A02) AD 339 916.*

131. Banks, J. E. "Manned Penetrations of Atomic Clouds, Project 2.8b." Washington, D. C.: DNA. WT-1156-EX. 09/01/80. 19 Pages. (A02) AD/A995 055.*/**

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

132. Bryant, E. J.; Ethridge, N. H.; Keefer, J. H. Measurements of Air-Blast Phenomena with Self-Recording Gages, Report to the Test Director, Project 1.14b. Aberdeen, MD.: Ballistic Research Laboratories. WT-1155. 07/16/59. 216 Pages. (A10) AD 617 170.*

133. Hendrickson, J. R. Shielding Studies, Operation TEAPOT, Project 2.7. Washington, D.C.: DNA. WT-1121-EX. 01/00/81. 122 Pages. (A06) AD/A995 103.*/**

134. Joint Test Organization, Military Effects Group. Correspondence File, Subject: Projects 2.2 and 2.7.1 Concerning Overexposure of Project Personnel for TESLA and MET. Mercury, NV. 00/00/55. 11 Pages.****

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

DISTRIBUTION LIST

DEPARTMENT OF DEFENSE

Armed Forces Staff College
ATTN: Library

Assistant Secretary of Defense, Public Affairs
ATTN: PAO

Defense Nuclear Agency
ATTN: PAO
ATTN: GC
ATTN: BA
5 cy ATTN: NTPR
25 cy ATTN: TITL

Defense Technical Information Center
12 cy ATTN: DD

Field Command
Defense Nuclear Agency
ATTN: FCLS
ATTN: FCLS, Maj D. Norton

Interservice Nuclear Weapons School
ATTN: TTV

National Defense University
ATTN: ICAF Tech Library

DEPARTMENT OF THE ARMY

Army Library
ATTN: Military Doc Sec

Army Nuclear Test Personnel Review
2 cy ATTN: DAAG-AMR-R TAGO

U.S. Army Center of Military History
ATTN: DAMH-HSO

U.S. Army Chemical School
ATTN: ATZN-CM-CS
ATTN: ATZN-CM-AL

U.S. Army Cmd & General Staff College
ATTN: Library

U.S. Army Nuclear & Chemical Agency
ATTN: Library

U.S. Army War College
ATTN: Library

DEPARTMENT OF THE NAVY

Aviation History Unit
Department of the Navy
ATTN: Library

Bureau of Medicine and Surgery
Department of the Navy
ATTN: Asst for Med Surgery

Engineering Duty Officer School
Department of the Navy
ATTN: Library

DEPARTMENT OF THE NAVY (Continued)

James Carson Breckinridge Library
Department of the Navy
ATTN: Library Div

Marine Corps Nuclear Test Personnel Review
ATTN: Code MSRB-60

Merchant Marine Academy
ATTN: Director of Libraries

Naval Aviation School Command
ATTN: Library

Naval Hospital Corps School
ATTN: Library

Naval Ocean Systems Center
ATTN: Library

Naval Oceanographic Office
ATTN: Code 025, Historian

Naval Postgraduate School
ATTN: Code 1424, Library

Naval Research Laboratory
ATTN: Library

Naval School
Naval Construction Battalion Center
ATTN: Commanding Officer

Naval School of Health Sciences
ATTN: Library

Naval Sea Systems Command
ATTN: Nuclear Technology Div

Naval Surface Weapons Center
ATTN: Library

Naval War College
ATTN: Professor & Libraries

Naval Weapons Center
ATTN: Code 233

Naval Weapons Evaluation Facility
ATTN: Library

Navy Dept Library
ATTN: Libm

Navy Nuclear Power School
ATTN: Library

Navy Nuclear Test Personnel Review
2 cy ATTN: W. Loeffler

U.S. Naval Academy
Nimitz Library
ATTN: Documents & Reports Dept

Marine Corps Base
ATTN: Document Custodian

DEPARTMENT OF THE NAVY (Continued)

Office of the Judge Adv Gen
Department of the Navy
ATTN: Code 73

Marine Corps Historical Center
2 cy ATTN: Code HDH-2

U.S. Merchant Marine Academy
ATTN: Librn

U.S. Naval Air Station Library
Department of the Navy
ATTN: Library

DEPARTMENT OF THE AIR FORCE

Academy Library DFSELD
U.S. Air Force Academy
ATTN: Library

Aerospace Defense Command
ATTN: Historian

Air Force Communications Command
ATTN: Historian

Air Force Institute of Technology
ATTN: Library

Air Force Logistics Command
ATTN: Historian

Air Force Nuclear Test Personnel Review
ATTN: HQ USAF/SGES

Air Force School of Aerospace Medicine
ATTN: Strughold Library

Air Force Systems Command
ATTN: Historian

Air Force Technical Applications Center
ATTN: Historian

Air Force Weapons Laboratory
Air Force Systems Command
ATTN: Tech Library

Air National Guard
ATTN: Historian

Air Training Command
ATTN: Historian

Air University Library
Department of the Air Force
ATTN: AUL-LSE

Military Air Lift Command
ATTN: Historian

Commander-in-Chief
Pacific Air Forces
ATTN: Historian

Tactical Air Command
Department of the Air Force
ATTN: Historian

DEPARTMENT OF THE AIR FORCE (Continued)

Strategic Air Command
Department of the Air Force
ATTN: NRI-STINFO Library
ATTN: Historian

U.S. Air Force Occupational & Env Health Lab
ATTN: NTPR

DEPARTMENT OF ENERGY

Department of Energy
ATTN: OMA

Department of Energy
Nevada Operations Office
ATTN: Health Physics Div
2 cy ATTN: R. Nutley

Department of Energy
Human Health & Assessments Division
ATTN: EV-31

OTHER GOVERNMENT AGENCIES

Centers for Disease Control
U.S. Public Health Service
ATTN: G. Caldwell

Central Intelligence Agency
ATTN: Office of Medical Services

Department of Health & Human Svcs
ATTN: Office of General Counsel

Exec Ofc of The President
Management & Budget Off Lib
ATTN: Librn

Library of Congress
ATTN: Library Service Division
ATTN: Science & Technology Div
ATTN: Serial & Govt Publication

National Atomic Museum
ATTN: Historian

Department of Commerce
National Bureau of Standards
ATTN: Librn

National Technical Information Service
12 cy ATTN: Customer Services

Occupational Safety & Health Admin
ATTN: C. Wright

Office of Health & Disability (ASPER)
ATTN: R. Copeland

Ofc of Workers Compensation Program
Department of Labor
ATTN: R. Larson

U.S. Coast Guard Academy Library
ATTN: Librn

U.S. House of Representatives
ATTN: Committee on Armed Svcs

OTHER GOVERNMENT AGENCIES (Continued)

U.S. House of Representatives
Committee on Interstate & Foreign Commerce
ATTN: Subcommittee on Health & Envir

U.S. Military Academy
ATTN: Director of Libraries

U.S. Senate
Committee on Armed Services
ATTN: Committee on Veterans Affairs

U.S. Senate
ATTN: Committee on Veterans Affairs

Veterans Administration-RO
Providence, RI
ATTN: Director

Veterans Administration-RO
Montgomery, AL
ATTN: Director

Veterans Administration-RO
Anchorage, AK
ATTN: Director

Veterans Administration-RO
Phoenix, AZ
ATTN: Director

Veterans Administration-RO
Little Rock, AR
ATTN: Director

Veterans Administration-RO
Los Angeles, CA
ATTN: Director

Veterans Administration-RO
San Francisco, CA
ATTN: Director

Veterans Administration-RO
Denver, CO
ATTN: Director

Veterans Administration-RO
Hartford, CT
ATTN: Director

Veterans Administration-RO
Wilmington, DE
ATTN: Director

Veterans Administration-OFC Central
Washington, D. C.
ATTN: Dept Veterans Benefit, Central Ofc
ATTN: Director
ATTN: Board of Veteran Appeal

Veterans Administration-RO
St. Petersburg, FL
ATTN: Director

Veterans Administration-RO
Atlanta, GA
ATTN: Director

OTHER GOVERNMENT AGENCIES (Continued)

Veterans Administration-RO
Honolulu, HI
ATTN: Director

Veterans Administration-RO
Chicago, IL
ATTN: Director

Veterans Administration-RO
Seattle, WA
ATTN: Director

Veterans Administration-RO
Indianapolis, IN
ATTN: Director

Veterans Administration-RO
Des Moines, IA
ATTN: Director

Veterans Administration-RO
Wichita, KS
ATTN: Director

Veterans Administration-RO
Louisville, KY
ATTN: Director

Veterans Administration-RO
New Orleans, LA
ATTN: Director

Veterans Administration-RO
Togus, ME
ATTN: Director

Veterans Administration-RO
Baltimore, MD
ATTN: Director

Veterans Administration-RO
Boston, MA
ATTN: Director

Veterans Administration-RO
St. Paul, MN
ATTN: Director

Veterans Administration-RO
Jackson, MS
ATTN: Director

Veterans Administration-RO
Huntington, WV
ATTN: Director

Veterans Administration-RO
St. Louis, MO
ATTN: Director

Veterans Administration-RO
Ft. Harrison, MT
ATTN: Director

OTHER GOVERNMENT AGENCIES (Continued)

Veterans Administration-RO
Lincoln, NE
ATTN: Director

Veterans Administration-RO
Reno, NV
ATTN: Director

Veterans Administration-RO
Manchester, NH
ATTN: Director

Veterans Administration-RO
Newark, NJ
ATTN: Director

Veterans Administration-RO
Milwaukee, WI
ATTN: Director

Veterans Administration-RO
Albuquerque, NM
ATTN: Director

Veterans Administration-RO
Buffalo, NY
ATTN: Director

Veterans Administration-RO
New York, NY
ATTN: Director

Veterans Administration-RO
Winston-Salem, NC
ATTN: Director

Veterans Administration-RO
Fargo, ND
ATTN: Director

Veterans Administration-RO
Cleveland, OH
ATTN: Director

Veterans Administration-RO
Muskogee, OK
ATTN: Director

Veterans Administration-RO
Portland, OR
ATTN: Director

Veterans Administration-RO
Pittsburgh, PA
ATTN: Director

Veterans Administration-RO
Philadelphia, PA
ATTN: Director

Veterans Administration-RO
San Francisco, CA
ATTN: Director

Veterans Administration-RO
San Juan, Puerto Rico
ATTN: Director

OTHER GOVERNMENT AGENCIES (Continued)

Veterans Administration-RO
Columbia, SC
ATTN: Director

Veterans Administration-RO
Sioux Falls, SD
ATTN: Director

Veterans Administration-RO
Houston, TX
ATTN: Director

Veterans Administration-RO
Waco, TX
ATTN: Director

Veterans Administration-RO
Salt Lake City, UT
ATTN: Director

Veterans Administraiton-RO
White River Junction, VT
ATT Director

Veterans Administration-RO
Roanoke, VA
ATTN: Director

Veterans Administration-RO
Cheyenne, WY
ATTN: Director

Veterans Administration-RO
San Diego, CA
ATTN: Director

Veterans Administration-RO
Boise, ID
ATTN: Director

Veterans Administration-RO
Detroit, MI
ATTN: Director

Veterans Administration-RO
Nashville, TN
ATTN: Director

The White House
ATTN: Domestic Policy Staff

DEPARTMENT OF ENERGY CONTRACTORS

Lawrence Livermore National Lab
ATTN: Tech Info Dept Library

Los Alamos National Lab
ATTN: Library
ATTN: ADPA MMS 195

Sandia National Lab
ATTN: W. Hereford
ATTN: Central Library

Reynolds Electrical & Engr Co., Inc
ATTN: CIC
ATTN: W. Brady

OTHER

Adams State College
ATTN: Librn

Akron Public Library
ATTN: Librn

Alabama State Dept of Archives & History
ATTN: Military Records Div

University of Alabama
ATTN: Reference Dept, Dralier 3
ATTN: Director of Libraries (Reg)

University of Alaska Library at Anchorage
ATTN: Librn

University of Alaska
ATTN: Dir of Libraries

Albany Public Library
ATTN: Librn

Alexander City State Jr College
ATTN: Librn

Allegheny College
ATTN: Librn

Allen County Public Library
ATTN: Librn

Altoona Area Public Library
ATTN: Librn

American Statistics Index
Congressional Info Service, Inc
ATTN: Cathy Jarvey

Anaheim Public Library
ATTN: Librn

College of Wooster
ATTN: Gov Docs

Angelo State University Library
ATTN: Librn

Angelo Iacoboni Public Library
ATTN: Librn

Anoka County Library
ATTN: Librn

Appalachian State University
ATTN: Library Docs

Arizona State University Library
ATTN: Librn

University of Arizona
ATTN: Gov Doc Dept/C. Bower

Arkansas College Library
ATTN: Library

Brooklyn College
ATTN: Doc Div

OTHER (Continued)

Arkansas Library Comm
ATTN: Library

Arkansas State University
ATTN: Library

University of Arkansas
ATTN: Gov Docs Div

Austin College
ATTN: Librn

Atlanta Public Library
ATTN: Ivan Allen Dept

Atlanta University
ATTN: Librn

Auburn University Library at Mongomery (Reg)
ATTN: Librn

C. W Post Ctr Long Island University
ATTN: Librn

Bangor Public Library
ATTN: Librn

Bates College Library
ATTN: Librn

Baylor University Library
ATTN: Docs Dept

Beloit College Libraries
ATTN: Serials Docs Dept

Bemidji State College
ATTN: Library

State University College
ATTN: Gov Docs

Akron University
ATTN: Gov Docs

Boston Public Library (Reg)
ATTN: Docs Dept

Bowdoin College
ATTN: Librn

Bowling Green State University
ATTN: Lib Gov Docs Services

Bradley University
ATTN: Librn

Brandeis University Library
ATTN: Docs Section

Brigham Young University
ATTN: Librn

Brigham Young University
ATTN: Docs Collection

Brookhaven National Laboratory
ATTN: Tech Library

OTHER (Continued)

Broward County Library Sys
ATTN: Librn

Brown University
ATTN: Librn

Bucknell University
ATTN: Reference Dept

Buffalo & Erie Co Public Library
ATTN: Librn

State University Library of California at Fresno
ATTN: Library

University Library of California at Los Angeles
ATTN: Pub Affairs Serv U.S. Docs

University of California at San Diego
ATTN: Docs Dept

State College Library of California at Stanislaus
ATTN: Library

California State Polytechnic University Library
ATTN: Librn

California State University at Northridge
ATTN: Gov Doc

California State Library (Reg)
ATTN: Librn

California State University at Long Beach Library
ATTN: Librn

California State University
ATTN: Librn

Califor State University
ATTN: Librn

California University Library
ATTN: Gov Pub Dept

California University Library
ATTN: Librn

California University Library
ATTN: Gov Docs Dept

California University Library
ATTN: Docs Sec

University of California
ATTN: Gov Docs Dept

Calvin College Library
ATTN: Librn

Kearney State College
ATTN: Gov Docs Dept

Cambria County Library Sys
ATTN: Librn

Carleton College Library
ATTN: Librn

OTHER (Continued)

Carnegie Library of Pittsburgh
ATTN: Librn

Carnegie Mellon University
ATTN: Dir of Libraries

Carson Regional Library
ATTN: Gov Pubs Unit

Case Western Reserve University
ATTN: Librn

Casper College
ATTN: Librn

University of Central Florida
ATTN: Library Docs Dept

Central Michigan University
ATTN: Library Docs Sec

Central Missouri State Univ
ATTN: Gov Docs

Central State University
ATTN: Lib Docs Dept

Central Washington University
ATTN: Lib Docs Sec

Central Wyoming College Library
ATTN: Librn

Charleston County Library
ATTN: Librn

Charlotte & Mechlenburg County Public Library
ATTN: E. Correll

Chattanooga Hamilton County, Bicentennial Library
ATTN: Librn

Chesapeake Public Library System
ATTN: Librn

Chicago Public Library
ATTN: Gov Pubs Dept

State University of Chicago
ATTN: Librn

Chicago University Library
ATTN: Dir of Libraries
ATTN: Docs Processing

Cincinnati University Library
ATTN: Librn

Citadel, Daniel Library
ATTN: Librn

Claremont Colleges Libraries
ATTN: Doc Collection

Clemson University
ATTN: Dir of Libraries

OTHER (Continued)

Cleveland Public Library
ATTN: Docs Collection

Cleveland State University Library
ATTN: Librn

Coe Library
ATTN: Docs Div

Colgate University Library
ATTN: Ref Lib

Colorado State University Libraries
ATTN: Librn

University of Colorado Libraries
ATTN: Dir of Libraries

Columbia University Library
ATTN: Docs Svc Ctr

Columbus & Franklin Cty Public Library
ATTN: Gen Rec Div

Compton Library
ATTN: Librn

Connecticut State Library (Reg)
ATTN: Librn

University of Connecticut
ATTN: Gov't of Connecticut

University of Connecticut
ATTN: Dir of Libraries

Cornell University Library
ATTN: Librn

Corpus Christi State University Library
ATTN: Librn

Culver City Library
ATTN: Librn

Curry College Library
ATTN: Librn

University of North Carolina at Asheville
ATTN: Librn

Dallas County Public Library
ATTN: Librn

Dallas Public Library
ATTN: Librn

Dalton Junior College Library
ATTN: Librn

Dartmouth College
ATTN: Librn

Davenport Public Library
ATTN: Librn

Davidson College
ATTN: Librn

OTHER (Continued)

Dayton & Montgomery City Public Library
ATTN: Librn

University of Dayton
ATTN: Librn

Decatur Public Library
ATTN: Librn

Dekalb Community College So Cpus
ATTN: Librn

Delaware Pauw University
ATTN: Librn

University of Delaware
ATTN: Librn

Delta College Library
ATTN: Librn

Delta State University
ATTN: Librn

Denison University Library
ATTN: Librn

Denver Public Library (Reg)
ATTN: Docs Div

Dept of Library & Archives (Reg)
ATTN: Librn

Detroit Public Library
ATTN: Librn

Dickinson College Library
ATTN: Librn

Dickinson State College
ATTN: Librn

Alabama Agricultural Mechanical University & Coll
ATTN: Librn

Drake University
ATTN: Cowles Library

Drew University
ATTN: Librn

Duke University
ATTN: Pub Docs Dept

Duluth Public Library
ATTN: Docs Sec

East Carolina University
ATTN: Lib Docs Dept

East Central University
ATTN: Librn

East Islip Public Library
ATTN: Librn

OTHER (Continued)

East Orange Public Library
ATTN: U.S. Gov't Depository

East Tennessee State University Sherrod Library
ATTN: Docs Dept

East Texas State University
ATTN: Library

Monmouth County Library Eastern Branch
ATTN: Librn

Eastern Illinois University
ATTN: Librn

Eastern Kentucky University
ATTN: Librn

Eastern Michigan University Library
ATTN: Library

Eastern Montana College Library
ATTN: Docs Dept

Eastern New Mexico University
ATTN: Librn

Eastern Oregon College Library
ATTN: Librn

Eastern Washington University
ATTN: Librn

El Paso Public Library
ATTN: Docs & Geneology Dept

Elko County Library
ATTN: Librn

Elmira College
ATTN: Librr

Elon College Library
ATTN: Librn

Enoch Pratt Free Library
ATTN: Docs Ofc

Emory University
ATTN: Librn

Evansville & Vanderburgh Cty Public Library
ATTN: Librn

Everett Public Library
ATTN: Librn

Fairleigh Dickinson University
ATTN: Depository Dept

Florida A & M University
ATTN: Librn

Florida Atlantic University Library
ATTN: Div of Pub Docs

OTHER (Continued)

Florida Institute of Technology
ATTN: Library

Florida International University Library
ATTN: Docs Sec

Florida State Library
ATTN: Docs Sec

Florida State University
ATTN: Librn

University of Florida
ATTN: Dir of Library (Reg)
ATTN: Docs Dept

Fond Du Lac Public Library
ATTN: Librn

Ft Hays State University
Ft Hays Kansas State College
ATTN: Librn

Ft Worth Public Library
ATTN: Librn

Free Public Library of Elizabeth
ATTN: Librn

Free Public Library
ATTN: Librn

Freeport Public Library
ATTN: Librn

Fresno Cty Free Library
ATTN: Librn

Gadsden Public Library
ATTN: Librn

Garden Public Library
ATTN: Librn

Gardner Webb College
ATTN: Docs Library

Gary Public Library
ATTN: Librn

Geauga Cty Public Library
ATTN: Librn

Georgetown University Library
ATTN: Gov Docs Room

Georgia Institute of Technology
ATTN: Librn

Georgia Southern College
ATTN: Librn

Georgia Southwestern College
ATTN: Dir of Libraries

Georgia State University Library
ATTN: Librn

OTHER (Continued)

University of Georgia
ATTN: Dir of Libraries (Reg)

Glassboro State College
ATTN: Librn

Gleeson Library
ATTN: Librn

Graceland College
ATTN: Librn

Grand Forks Public City-County Library
ATTN: Librn

Grand Rapids Public Library
ATTN: Dir of Lib

Greenville County Library
ATTN: Librn

Grinnell College Library
ATTN: Librn

Guam RFK Memorial University Library
ATTN: Fed Depository Coll

University of Guam
ATTN: Librn

Gustavus A phus College
ATTN: Librn

South Dakota University
ATTN: Librn

Hardin-Simmons University Library
ATTN: Librn

Hartford Public Library
ATTN: Librn

Harvard College Library
ATTN: Dir of Lib

Harvard College Library
ATTN: Serials Rec Div

University of Hawaii Library
ATTN: Gov Docs Coll

Hawaii State Library
ATTN: Fed Docs Unit

University of Hawaii at Monoa
ATTN: Dir of Libraries (Reg)

University of Hawaii
Hilo Campus Library
ATTN: Librn

Haydon Burns Library
ATTN: Librn

Hennepin County Library
ATTN: Gov Docs

Henry Ford Community College Library
ATTN: Librn

OTHER (Continued)

Herbert H. Lehman College
ATTN: Lib Docs Div

Hofstra University Library
ATTN: Docs Dept

Hollins College
ATTN: Librn

Hopkinsville Community College
ATTN: Librn

Wagner College
ATTN: Librn

University of Houston Library
ATTN: Docs Div

Houston Public Library
ATTN: Librn

Tulane University
ATTN: Docs Dept

Hoyt Public Library
ATTN: Libin

Humboldt State College Library
ATTN: Docs Dept

Huntington Park Library
ATTN: Librn

Hutchinson Public Library
ATTN: Librn

Idaho Public Library & Information Center
ATTN: Librn

Idaho State Library
ATTN: Librn

Idaho State University Library
ATTN: Docs Dept

University of Idaho
ATTN: Dir of Libraries (Reg)
ATTN: Docs Sec

University of Illinois Library
ATTN: Docs Sec

Illinois State Library (Reg)
ATTN: Gov Docs Br

Illinois University at Urbana-Champaign
ATTN: P. Watson Docs Lib

Illinois Valley Community College
ATTN: Library

Illinois State University
ATTN: Librn

Indiana State Library (Reg)
ATTN: Serial Sec

Indiana State University
ATTN: Docs Library

OTHER (Continued)

Indiana University Library
ATTN: Docs Dept

Indianapolis Marion County Public Library
ATTN: Social Science Div

Iowa State University Library
ATTN: Gov Docs Dept

Iowa University Library
ATTN: Gov Docs Dept

Butler University
ATTN: Librn

Isaac Delchdo College
ATTN: Librn

James Madison University
ATTN: Librn

Jefferson County Public Library
Lakewood Regional Library
ATTN: Librn

Jersey City State College
ATTN: F. A. Irwin Library Periodicals
Doc Sec

Johns Hopkins University
ATTN: Docs Library

La Roche College
ATTN: Librn

Johnson Free Public Library
ATTN: Librn

Kalamazoo Public Library
ATTN: Librn

Kansas City Public Library
ATTN: Docs Div

Kansas State Library
ATTN: Librn

Kansas State University Library
ATTN: Docs Dept

University of Kansas
ATTN: Dir of Library (Reg)

University of Texas
ATTN: Lyndon B. Johnson School of Public
Affairs Library

Maine Maritime Academy
ATTN: Librn

University of Maine
ATTN: Librn

OTHER (Continued)

Kent State University Library
ATTN: Docs Div

Kentucky Dept of Library & Archives
ATTN: Docs Sec

University of Kentucky
ATTN: Gov Pub Dept
ATTN: Dir of Lib (Reg)

Kenyon College Library
ATTN: Librn

Lake Forest College
ATTN: Librn

Lake Sumter Community College Library
ATTN: Librn

Lakeland Public Library
ATTN: Librn

Lancaster Regional Library
ATTN: Librn

Lawrence University
ATTN: Docs Dept

Brigham Young University
ATTN: Docs & Map Sec

Lewis University Library
ATTN: Librn

Library and Statutory Dist & Svc
2 cy ATTN: Librn

Earlham College
ATTN: Librn

Little Rock Public Library
ATTN: Librn

Long Beach Public Library
ATTN: Librn

Los Angeles Public Library
ATTN: Serials Div U.S. Docs

Louisiana State University
ATTN: Gov Doc Dept
ATTN: Dir of Libraries (Reg)

Louisville Free Public Library
ATTN: Librn

Louisville University Library
ATTN: Librn

Hoover Institution
ATTN: J. Bingham

OTHER (Continued)

Manchester City Library
ATTN: Librn

Mankato State College
ATTN: Gov Pubs

University of Maine at Farmington
ATTN: Dir of Libraries

Marathon County Public Library
ATTN: Librn

Principia College
ATTN: Librn

University of Maryland
ATTN: McKeldin Library Docs Div

University of Maryland
ATTN: Librn

University of Massachusetts
ATTN: Gov Docs Coll

Maui Public Library
Kahului Branch
ATTN: Librn

McNeese State University
ATTN: Librn

Memphis & Shelby County Public Library &
Information Center
ATTN: Librn

Memphis State University
ATTN: Librn

Mercer University
ATTN: Librn

Mesa County Public Library
ATTN: Librn

Miami Dade Community College
ATTN: Librn

University of Miami Library
ATTN: Gov Pubs

Miami Public Library
ATTN: Docs Div

Miami University Library
ATTN: Docs Dept

University of Santa Clara
ATTN: Docs Div

Michigan State Library
ATTN: Librn

Michigan State University Library
ATTN: Librn

Murray State University Library
ATTN: Lib

OTHER (Continued)

Michigan Tech University
ATTN: Lib Docs Dept

University of Michigan
ATTN: Acq Sec Docs Unit

Middlebury College Library
ATTN: Librn

Millersville State College
ATTN: Librn

State University of New York
ATTN: Docs Librn

Milwaukee Public Library
ATTN: Librn

Minneapolis Public Library
ATTN: Librn

University of Minnesota
ATTN: Dir of Libraries (Reg)

Minot State College
ATTN: Librn

Mississippi State University
ATTN: Librn

University of Mississippi
ATTN: Dir of Libraries

Missouri University at Kansas City General
ATTN: Librn

University of Missouri Library
ATTN: Gov Docs

M.I.T. Libraries
ATTN: Librn

Mobile Public Library
ATTN: Gov Info Div

Midwestern University
ATTN: Librn

Montana State Library
ATTN: Librn

Montana State University Library
ATTN: Librn

University of Montana
ATTN: Dir of Libraries (Reg)

Montebello Library
ATTN: Librn

Moorhead State College
ATTN: Library

Mt Prospect Public Library
ATTN: Gov't Info Ctr

OTHER (Continued)

Nassau Library System
ATTN: Librn

Natrona County Public Library
ATTN: Librn

Nebraska Library Community
Nebraska Public Clearinghouse
ATTN: Librn

University of Nebraska at Omaha
ATTN: Univ Lib Docs

Nebraska Western College Library
ATTN: Librn

University of Nebraska
ATTN: Dir of Libraries (Reg)

University of Nebraska Library
ATTN: Acquisitions Dept

University of Nevada Library
ATTN: Gov Pubs Dept

University of Nevada at Las Vegas
ATTN: Dir of Libraries

New Hampshire University Library
ATTN: Librn

New Hanover County Public Library
ATTN: Librn

New Mexico State Library
ATTN: Librn

New Mexico State University
ATTN: Lib Docs Div

University of New Mexico
ATTN: Dir of Libraries (Reg)

University of New Orleans Library
ATTN: Gov Docs Div

New Orleans Public Library
ATTN: Librn

New York Public Library
ATTN: Librn

New York State Library
ATTN: Docs Control Cultural Ed Ctr

State University of New York at Stony Brook
ATTN: Main Lib Docs Sec

State University of New York College Memorial Lib
at Cortland
ATTN: Librn

State University of New York
ATTN: Lib Docs Sec

North Texas State University Library
ATTN: Librn

OTHER (Continued)

State University of New York
ATTN: Librn

New York State University
ATTN: Docs Ctr

State University of New York
ATTN: Docs Dept

New York University Library
ATTN: Docs Dept

Newark Free Library
ATTN: Librn

Newark Public Library
ATTN: Librn

Niagara Falls Public Library
ATTN: Librn

Nicholls State University Library
ATTN: Docs Div

Nieves M. Flores Memorial Library
ATTN: Librn

Norfolk Public Library
ATTN: R. Parker

North Carolina Agricultural & Tech State
University
ATTN: Librn

University of North Carolina at Charlotte
ATTN: Atkins Lib Doc Dept

University Library of North Carolina at Greensboro
ATTN: Librn

University of North Carolina at Wilmington
ATTN: Librn

North Carolina Central University
ATTN: Librn

North Carolina State University
ATTN: Librn

University of North Carolina
ATTN: BA SS Div Docs

North Dakota State University Library
ATTN: Docs Librn

University of North Dakota
ATTN: Librn

North Georgia College
ATTN: Librn

Minnesota Div of Emergency Svcs
ATTN: Librn

OTHER (Continued)

Northeast Missouri State University
ATTN: Librn

Northeastern Oklahoma State University
ATTN: Librn

Northeastern University
ATTN: Dodge Library

Northern Arizona University Library
ATTN: Gov Docs Dept

Northern Illinois University
ATTN: Librn

Northern Michigan University
ATTN: Docs

Northern Montana College Library
ATTN: Librn

Northwestern Michigan College
ATTN: Librn

Northwestern State University
ATTN: Librn

Northwestern State University Library
ATTN: Librn

Northwestern University Library
ATTN: Gov Pubs Dept

Norwalk Public Library
ATTN: Librn

Northeastern Illinois University
ATTN: Library

University of Notre Dame
ATTN: Doc Ctr

Oakland Community College
ATTN: Librn

Oakland Public Library
ATTN: Librn

Oberlin College Library
ATTN: Librn

Ocean County College
ATTN: Librn

Ohio State Library
ATTN: Librn

Ohio State University
ATTN: Lib Docs Div

Ohio University Library
ATTN: Docs Dept

Oklahoma City University Library
ATTN: Librn

Oklahoma City University Library
ATTN: Librn

OTHER (Continued)

Oklahoma Department of Libraries
ATTN: U.S. Gov Docs

University of Oklahoma
ATTN: Docs Div

Old Dominion University
ATTN: Doc Dept Univ Lib

Olivet College Library
ATTN: Librn

Omaha Public Library Clark Branch
ATTN: Librn

Onondaga County Public Library
ATTN: Gov Docs Sec

Oregon State Library
ATTN: Librn

University of Oregon
ATTN: Docs Sec

Ouachita Baptist University
ATTN: Librn

Pan American University Library
ATTN: Librn

Passaic Public Library
ATTN: Librn

Queens College
ATTN: Docs Dept

Pennsylvania State Library
ATTN: Gov Pubs Sec

Pennsylvania State University
ATTN: Lib Doc Sec

University of Pennsylvania
ATTN: Dir of Libraries

University of Denver
ATTN: Penrose Library

Peoria Public Library
ATTN: Business, Science & Tech Dept

Free Library of Philadelphia
ATTN: Gov Pubs Dept

Philipsburg Free Public Library
ATTN: Library

Phoenix Public Library
ATTN: Librn

University of Pittsburgh
ATTN: Docs Office, G8

Plainfield Public Library
ATTN: Librn

OTHER (Continued)

Popular Creek Public Library District
ATTN: Librn

Association of Portland Library
ATTN: Librn

Portland Public Library
ATTN: Librn

Portland State University Library
ATTN: Librn

Pratt Institute Library
ATTN: Librn

Louisiana Tech University
ATTN: Librn

Princeton University Library
ATTN: Docs Div

Providence College
ATTN: Librn

Providence Public Library
ATTN: Librn

Public Library Cincinnati & Hamilton County
ATTN: Librn

Public Library of Nashville and Davidson Coun
ATTN: Librn

University of Puerto Rico
ATTN: Doc & Maps Room

Purdue University Library
ATTN: Librn

Quinebaug Valley Community College
ATTN: Librn

Auburn University
ATTN: Microforms & Docs Dept

Rapid City Public Library
ATTN: Librn

Reading Public Library
ATTN: Librn

Reed College Library
ATTN: Librn

Augusta College
ATTN: Librn

University of Rhode Island Library
ATTN: Gov Pubs Ofc

University of Rhode Island
ATTN: Dir of Libraries

Rice University
ATTN: Dir of Libraries

Louisiana College
ATTN: Librn

OTHER (Continued)

Richland County Public Library
ATTN: Librn

Riverside Public Library
ATTN: Librn

University of Rochester Library
ATTN: Docs Sec

University of Rutgers Camden Library
ATTN: Librn

State University of Rutgers
ATTN: Librn

Rutgers University
ATTN: Dir of Libraries (Reg)

Rutgers University Law Library
ATTN: Fed Docs Dept

Salem College Library
ATTN: Librn

Samford University
ATTN: Librn

San Antonio Public Library
ATTN: Bus Science & Tech Dept

San Diego County Library
ATTN: C. Jones, Acquisitions

San Diego Public Library
ATTN: Librn

San Diego State University Library
ATTN: Gov Pubs Dept

San Francisco Public Library
ATTN: Gov Docs Dept

San Francisco State College
ATTN: Gov Pubs Coll

San Jose State College Library
ATTN: Docs Dept

San Luis Obispo City-County Library
ATTN: Librn

Savannah Public & Effingham Liberty Regional Library
ATTN: Librn

Scottsbluff Public Library
ATTN: Librn

Scranton Public Library
ATTN: Librn

Seattle Public Library
ATTN: Ref Docs Asst

OTHER (Continued)

Selby Public Library
ATTN: Librn

Shawnee Library System
ATTN: Librn

Shreve Memorial Library
ATTN: Librn

Silas Bronson Public Library
ATTN: Librn

Sioux City Public Library
ATTN: Librn

Skidmore College
ATTN: Librn

Slippery Rock State College Library
ATTN: Librn

South Carolina State Library
ATTN: Librn

University of South Carolina
ATTN: Librn

University of South Carolina
ATTN: Gov Docs

South Dakota School of Mines & Technical Library
ATTN: Librn

South Dakota State Library
ATTN: Fed Docs Dept

University of South Dakota
ATTN: Docs Librn

South Florida University Library
ATTN: Librn

Southeast Missouri State University
ATTN: Librn

Southeastern Massachusetts University Library
ATTN: Docs Sec

University of Southern Alabama
ATTN: Librn

Southern California University Library
ATTN: Docs Dept

Southern Connecticut State College
ATTN: Library

Southern Illinois University
ATTN: Librn

Southern Illinois University
ATTN: Docs Ctr

Southern Methodist University
ATTN: Librn

University of Southern Mississippi
ATTN: Library

OTHER (Continued)

Southern Oregon College
ATTN: Library

Southern University in New Orleans Library
ATTN: Librn

Southern Utah State College Library
ATTN: Docs Dept

Southwest Missouri State College
ATTN: Library

University of Southwestern Louisiana Libraries
ATTN: Librn

Southwestern University
ATTN: Librn

Spokane Public Library
ATTN: Ref Dept

Springfield City Library
ATTN: Docs Sec

St Bonaventure University
ATTN: Librn

St Johns River Junior College
ATTN: Library

St Joseph Public Library
ATTN: Librn

St Lawrence University
ATTN: Librn

St Louis Public Library
ATTN: Librn

St Paul Public Library
ATTN: Librn

Stanford University Library
ATTN: Gov Docs Dept

State Historical Soc Library
ATTN: Docs Serials Sec

State Library of Massachusetts
ATTN: Librn

State University of New York
ATTN: Librn

Stetson University
ATTN: Librn

University of Steubenville
ATTN: Librn

Stockton & San Joaquin Public Library
ATTN: Librn

Stockton State College Library
ATTN: Librn

Albion College
ATTN: Gov Docs Librn

OTHER (Continued)

Superior Public Library
ATTN: Librn

Swarthmore College Library
ATTN: Ref Dept

Syracuse University Library
ATTN: Docs Div

Tacoma Public Library
ATTN: Librn

Hillsborough County Public Library at Tampa
ATTN: Librn

Temple University
ATTN: Librn

Tennessee Technological University
ATTN: Librn

University of Tennessee
ATTN: Dir of Libraries

College of Idaho
ATTN: Librn

Texas A & M University Library
ATTN: Librn

University of Texas at Arlington
ATTN: Library Docs

University of Texas at San Antonio
ATTN: Library

Texas Christian University
ATTN: Librn

Texas State Library
ATTN: U.S. Docs Sec

Texas Tech University Library
ATTN: Gov Docs Dept

Texas University at Austin
ATTN: Docs Coll

University of Toledo Library
ATTN: Librn

Toledo Public Library
ATTN: Social Science Dept

Torrance Civic Center Library
ATTN: Librn

Traverse City Public Library
ATTN: Librn

Trenton Free Public Library
ATTN: Librn

Trinity College Library
ATTN: Librn

Trinity University Library
ATTN: Docs Coll

OTHER (Continued)

Tufts University Library
ATTN: Docs Dept

University of Tulsa
ATTN: Librn

UCLA Research Library
ATTN: Pub Affairs Svc/U.S. Docs

Uniformed Services University of the Health Sciences
ATTN: LRC Library

University Libraries
ATTN: Dir of Lib

University of Maine at Oreno
ATTN: Librn

University of Northern Iowa
ATTN: Library

Upper Iowa College
ATTN: Docs Coll

Utah State University
ATTN: Librn

University of Utah
ATTN: Special Collections

University of Utah
ATTN: Dir of Library

Utica Public Library
ATTN: Librn

Valencia Library
ATTN: Librn

Valparaiso University
ATTN: Librn

Vanderbilt University Library
ATTN: Gov Docs Sec

University of Vermont
ATTN: Dir of Libraries

Virginia Commonwealth University
ATTN: Librn

Virginia Military Institute
ATTN: Librn

Virginia Polytechnic Institute Library
ATTN: Docs Dept

Virginia State Library
ATTN: Serials Sec

University of Virginia
ATTN: Pub Docs

Volusia County Public Library
ATTN: Librn

OTHER (Continued)

Washington State Library
ATTN: Docs Sec

Washington State University
ATTN: Lib Docs Sec

Washington University Libraries
ATTN: Dir of Lib

University of Washington
ATTN: Docs Div

Wayne State University Library
ATTN: Librn

Wayne State University Law Library
ATTN: Docs Dept

Weber State College Library
ATTN: Librn

Wesleyan University
ATTN: Docs Librn

West Chester State College
ATTN: Docs Dept

West Covina Library
ATTN: Librn

University of West Florida
ATTN: Librn

West Georgia College
ATTN: Librn

West Hills Community College
ATTN: Library

West Texas State University
ATTN: Library

West Virginia College of Grad Studies Library
ATTN: Librn

University of West Virginia
ATTN: Dir of Libraries (Reg)

Westerly Public Library
ATTN: Librn

Western Carolina University
ATTN: Librn

Western Illinois University Library
ATTN: Librn

Western Washington University
ATTN: Librn

Western Wyoming Community College Library
ATTN: Librn

Westmoreland City Community College
ATTN: Learning Resource Ctr

OTHER (Continued)

Whitman College
ATTN: Librn

Wichita State University Library
ATTN: Librn

Williams & Mary College
ATTN: Docs Dept

Emporia Kansas State College
ATTN: Gov Docs Div

William College Library
ATTN: Librn

Willimantic Public Library
ATTN: Librn

Winthrop College
ATTN: Docs Dept

University of Wisconsin at Whitewater
ATTN: Gov Docs Lib

University of Wisconsin at Milwaukee
ATTN: Lib Docs

University of Wisconsin at Oshkosh
ATTN: Librn

University of Wisconsin at Platteville
ATTN: Doc Unit Lib

University of Wisconsin at Stevens Point
ATTN: Docs Sec

University of Wisconsin
ATTN: Gov Pubs Dept

University of Wisconsin
ATTN: Acquisitions Dept

Worcester Public Library
ATTN: Librn

Wright State University Library
ATTN: Gov Docs Librn

Wyoming State Library
ATTN: Librn

University of Wyoming
ATTN: Docs Div

Yale University
ATTN: Dir of Libraries

Yeshiva University
ATTN: Librn

Yuma City County Library
ATTN: Librn

Simon Schwob Mem Lib, Columbus Col
ATTN: Librn

DEPARTMENT OF DEFENSE CONTRACTORS

Advanced Research & Applications Corp
ATTN: H. Lee

JAYCOR
ATTN: A. Nelson
2 cy ATTN: Health & Environment Div

Kaman Tempo
ATTN: DASIAC
ATTN: E. Martin

Kaman Tempo
ATTN: R. Miller

Science Applications, Inc
JRB Associates Div
10 cy ATTN: I Novotney

DEPARTMENT OF DEFENSE CONTRACTORS (Continued)

Kaman Tempo
ATTN: C. Jones

National Academy of Sciences
ATTN: C. Robinette
ATTN: Med Follow-up Agency
ATTN: Nat Mat Advisory Bd

Pacific-Sierra Research Corp
ATTN: H. Brode

Science Applications, Inc
ATTN: Tech Lib

R & D Associates
ATTN: P. Haas